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Office of Radiation Programs

INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

Multiples and submultiples	Prefixes	Symbols	Pronunciations
10^{12}	tera	T	těr'a
10^{9}	giga	G	jĭ'ga
10^{6}	mega	M	měg'a
10^{3}	kilo	k	kĭ'lo
10^{2}	hecto	h	hĕk'to
10	deka	da	dĕk'a
10^{-1}	deci	d	dĕs'i
10^{-2}	centi	c	sĕn'ti
10^{-3}	milli	m	mĭl'i
10^{-6}	micro	μ	mi'kro
10^{-9}	nano	n	năn'o
10^{-12}	pico	p	pē'ko
10^{-15}	femto	f	fĕm'to
10^{-18}	atto	a	ăt'to

SYMBOLS, UNITS, AND EQUIVALENTS

Symbol	Unit	Equivalent
Å	angstrom	10^{-10} meter
A	ampere(s)	
a	annum, year	
BeV	billion electron volts	GeV
Ci	curie	3.7×10^{10} dps-2.22×10^{12} dpm
cpm	counts per minute	
dpm	disintegrations per minute	
dps	disintegrations per second	
eV	electron volt	1.6×10^{-12} ergs
g	gram(s)	3.527×10^{-2} ounces= 2.205×10^{-3} pounds
Hz	hertz	cycle per second
kVp	kilovolt peak	
m	meter(s)	39.4 inches=3.28 feet
m^3	cubic meter(s)	
mCi/mi^2	millicuries per square mile	0.386 nCi/m^2 (mCi/km^2)
mi	mile(s)	
ml	milliliter(s)	
nCi/m^2	nanocuries per square meter	2.59 mCi/mi^2
R	roentgen	
rad	unit of absorbed radiation dose	100 ergs/g
r/min	revolutions per minute	
s	second	
yr	year	

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RADIATION DATA AND REPORTS

Volume 15, Number 12, December 1974

Radiation Data and Reports, a monthly publication of the Environmental Protection Agency, presents data and reports provided by Federal, State, and foreign governmental agencies, and other cooperating organizations. Pertinent original data and interpretive manuscripts are invited from investigators.

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. This responsibility was delegated to the Bureau of Radiological Health, Public Health Service. Pursuant to the Reorganization Plan No. 3 of 1970, effective December 2, 1970, this responsibility was transferred to the Radiation Office of the Environmental Protection Agency which was established by this reorganization.

The Federal agencies listed below appoint their representatives to a Board of Editorial Advisors. Members of the Board advise on general publications policy; secure appropriate data and manuscripts from their agencies; and review those contents which relate to the special functions of their agencies.

Department of Defense
Department of Agriculture
Department of Commerce
Department of Health, Education, and Welfare
Environmental Protection Agency
Atomic Energy Commission

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DATA AND REPORTS

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U.S. ENVIRONMENTAL PROTECTION AGENCY
Russell E. Train, Administrator

NOTICE

This issue of *Radiation Data and Reports,* which marks the completion of fifteen volume years of monthly publication, is its final issue.

Future publications of the Office of Radiation Programs, Environmental Protection Agency, will take new directions in emphasis and presentation of information. These publications will present information in depth, with interpretations leading to assessments of the environmental and health significance of radiation and analyses of trends. Reports of individual investigations by scientists in the field will no longer be published.

For those who have a need for specific raw data from the ERAMS program, these can be obtained by request to the

Eastern Environmental Radiation Facility
Environmental Protection Agency
P.O. Box 3009
Montgomery, Alabama 36109

The Office of Radiation Programs takes this opportunity to acknowledge the past support of our readers, and the contributions of so many who cooperated with us in the past. We look forward to opportunities for continued service, with our new format, to the agencies, organizations, and individuals, and to the public, in our role of providing focus on the various radiation problems that concern our society.

W. D. Rowe

W. D. Rowe, Ph.D.
Deputy Assistant Administrator
for Radiation Programs

A Summary of Low-Level Radioactive Wastes Buried at Commercial Sites Between 1962-1973, with Projections to the Year 2000

M. F. O'Connell[1] *and W. F. Holcomb*[2]

The U.S. Environmental Protection Agency contracted with the six States having commercial burial facilities for low-level radioactive wastes to obtain inventories of the types and quantities of wastes buried at these six sites. A compilation and interpretation of the inventory data is presented in tables and figures. Projections are made to the year 2000 of the quantity of low-level radioactive wastes that will result from the nuclear fuel cycle and nonfuel cycle sources. In addition, assumptions are made relating these projections to the available capacity and operational life of the commercial sites. Based on estimates of waste generation rates, it is indicated, assuming present operational practices, that by the year 1998, the six existing sites will exhaust their current burial capacity.

The disposal of low-level radioactive wastes at commercially-operated burial sites began in 1962 at Beatty, Nev. Since that time, the industry has expanded to include three private companies operating six sites. The sites are located at Maxey Flats, Ky.; Beatty, Nev.; Sheffield, Ill.; Barnwell, S.C.; West Valley, N.Y.; and Richland, Wash. The three companies operating these facilities are Nuclear Engineering Company (Washington, Nevada, Illinois and Kentucky), Chem Nuclear Systems, Incorporated (South Carolina), and Nuclear Fuel Services (New York). Earlier reports have described these sites in some detail (*1,2,3*). These facilities are located in remote areas in geologic conditions which were considered suitable for the purpose of shallow land burial of low-level radioactive wastes.

The burial facilities are managed by private industry, but, by regulation, are located upon Federal- or State-owned land (*4*) and have controlled access. They are, in general, regulated by the State in which they are located, according to the provision of agreements between the individual States and the U.S. Atomic Energy Commission (AEC). The one exception is the site located at Sheffield, Ill., which is regulated directly by the AEC. At two sites, those located in Nevada and Washington, the AEC has retained the licensing and regulation of the handling of special nuclear material.

The licenses for the burial of radioactive waste generally contain provisions for site maintenance, inventory control, health and safety, and environmental monitoring. The AEC and agreement States have issued a total of 29 other licenses to companies for the purpose of collecting, packaging, storing, and transporting radioactive wastes from the users of radioactive materials to the commercial disposal facilities. These companies are not involved with the actual disposal of the waste, but act only as intermediaries (*5*).

The burial facilities were initially to receive the radioactive wastes from hospitals, research facilities, and industries using radioisotopes. However, over the past 11 years, these sites have also been used increasingly for the disposal of contaminated waste material and equipment from the growing commercial nuclear power industry (fuel fabrication, reactor operation, and fuel reprocessing).

In the latter part of 1971, the U.S. Environmental Protection Agency's Office of Radiation Programs (ORP) contracted with each of the six States to obtain complete inventories of the types and quantities of byproduct material, source material, special nuclear material and

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liquid waste buried from the time the site began operation through 1973. The data submitted by the States were taken from periodic reports prepared and submitted by the companies operating the burial sites. The companies tabulate the waste burial data from shipping records prepared by the facilities shipping waste to the burial site for disposal.

Presentation of inventory data

Low-level solid radioactive wastes are those which neither originate from the first extraction process of the nuclear fuel reprocessing operation nor generate sufficient heat or radiation so as to require special cooling or shielding. These low-level wastes are categorized, depending upon the isotopes they contain, as byproduct, special nuclear material, and source material and are briefly defined below (*4*):

1. *Byproduct material* (reported in curies) refers to any radioactive material (except nuclear material and source material) obtained during the production or use of source or special nuclear material and includes fission products and other radioisotopes.
2. *Source material* (reported in pounds) refers to thorium or uranium or any combination thereof, in any physical or chemical form. Source material does not include special nuclear material.
3. *Special nuclear material* (SNM) (reported in grams) refers to plutonium, uranium-233, uranium containing more than the natural abundance of the isotope 235 or any material artificially enriched in any of these substances. SNM does not include source material.

Tables 1 through 5 present a compilation of the State inventory data. The accompanying figures 1 through 5 present these data where comparisons between sites can be made and regional or national trends can be observed.

Interpretation of figures

Figure 1 shows a continuing increase in the volume of waste being buried over the reporting period. Notably, the South Carolina facility, though only opened in 1971, has quickly become one of the nation's major burial sites. This is not unexpected since the growth of the nuclear industry in the southeastern United States has been greater than in most other regions. From current nuclear power projections and other indications of planned nuclear industry growth, it is estimated that this region will become a major contributor of low-level radioactive solid waste. Before this site opened in 1971, the major burial facility in the United States was the one located in Kentucky, receiving almost 40 percent of the volume of all low-level wastes being buried at commercial facilities. The Kentucky site will probably continue to receive large volumes of waste for burial, but it is expected that the other burial facilities will be utilized to a greater extent in the future

Table 1. Volume of radioactive wastes buried at commercial sites, 1962–1973

Year	Volume (cubic feet)							
	Kentucky	Nevada	South Carolina	Illinois	New York	Washington	National annual total	National cumulative total
1962		65 704					65 704	65 704
1963	77 905	124 035			18 425		220 365	286 069
1964	136 736	100 150			225 597		462 483	748 552
1965	203 109	70 195			166 564	23 602	463 470	1 212 022
1966	196 205	124 779			165 872	84 839	571 695	1 783 717
1967	276 158	113 228		89 240	174 657	30 705	683 988	2 467 705
1968	288 757	126 272		95 805	159 084	23 620	693 538	3 161 243
1969	365 596	151 202		71 053	150 948	15 463	754 262	3 915 505
1970	442 128	145 895		99 760	179 960	14 923	882 666	4 798 171
1971	465 145	126 558	48 253	156 455	224 687	20 615	1 041 713	5 839 884
1972	550 082	151 901	159 485	210 336	249 117	235 895	1 556 816	7 396 700
1973	355 703	143 930	603 876	301 018	[a] 250 000	[a] 100 000	[a] 1 750 000	[a] 9 150 000
Total	3 357 524	1 443 849	811 614	1 023 667	[a] 1 960 000	[a] 550 000	[a] 1 750 000	[a] 9 150 000

[a] Estimated.

Table 2. Byproduct material buried at commercial sites, 1962–1973

Year	Byproduct material (curies)							
	Kentucky	Nevada	South Carolina	Illinois	New York [a]	Washington	National annual total	National cumulative total
1962								
1963	22 556	5 690			1 372		29 618	29 618
1964	147 218	6 477			11 355		165 050	194 668
1965	63 828	6 377			21 515	144	91 864	286 532
1966	52 737	11 974			41 056	1 006	106 773	393 305
1967	23 272	10 894		3 850	51 230	5 378	94 624	487 929
1968	45 578	6 808		2 381	51 675	10 330	116 772	604 701
1969	31 028	9 761		2 192	23 264	55 964	122 209	726 910
1970	56 969	12 304		5 427	36 291	52 820	163 811	890 721
1971	710 147	4 316	224	7 895	42 458	23 916	788 956	1 679 677
1972	217 350	5 228	13 682	4 857	61 208	20 000	322 325	2 002 002
1973	123 779	5 704	107 662	2 834	[b] 40 000	[b] 25 000	[b] 300 000	[b] 2 300 000
Total	1 494 462	85 533	121 568	29 436	[b] 380 000	[b] 190 000		[b] 2 300 000

[a] Plutonium-238 subtracted from figures in column. New York reports plutonium-238 as byproduct material instead of special nuclear material, whereas the other States report plutonium-238 as special nuclear material.
[b] Estimated.

Table 3. Special nuclear material buried at commercial sites, 1962–1973

Year	Special nuclear material (grams)							
	Kentucky	Nevada	South Carolina	Illinois	New York [a]	Washington	National annual total	National cumulative total
1962		319					319	319
1963	959	41 304			952		43 215	43 534
1964	11 770	172 030			3 273		187 073	230 607
1965	4 261	334 762			2 433	3	341 459	572 066
1966	7 462	5 872			4 999	1 418	19 751	591 817
1967	14 842	22 644		1 238	3 446		42 170	633 987
1968	17 771	8 602		1 754	2 045		30 172	664 159
1969	31 506	5 005		3 843	7 301	32	47 687	711 846
1970	47 562	7 708		5 649	8 273	200	69 392	781 238
1971	72 770	757	55 877	9 934	4 816	15	144 169	925 407
1972	71 443	21 177	64 993	5 898	7 321		170 832	1 096 239
1973	46 249	15 164	77 149	6 126	[b] 4 000		[b] 150 000	[b] 1 240 000
Total	326 595	635 344	198 019	34 442	[b] 490 000	1 668		[b] 1 240 000

[a] Plutonium-238 added to figures supplied by New York State.
[b] Estimated.

Table 4. Source material buried at commercial sites, 1962–1973

Year	Source material (pounds)							
	Kentucky	Nevada	South Carolina	Illinois	New York	Washington	National annual total	National cumulative total
1962		653					653	653
1963	11 487	1 041			16 716		29 244	29 897
1964	12 333	729			22 197		35 259	65 156
1965	1 252	520			48 987	2	50 761	115 917
1966	1 521	200			84 492	558	86 771	202 688
1967	12 516	763		8 664	44 699	2	66 644	269 332
1968	13 772	2 300		19 192	14 244	6	49 514	318 846
1969	5 631	639		13 963	176 401	195	196 829	515 675
1970	15 913	711		4 420	69 931	69	90 044	606 719
1971	12 643		26 716	467	113 438	1 337	154 601	761 320
1972	18 205	20 596	35 057	7 927	159 930	[a] 4 000	[a] 246 000	[a] 1 007 000
1973	24 224	25 264	86 111	5 310	[a] 100 000	[a] 5 000	[a] 245 000	[a] 1 250 000
Total	129 497	53 416	147 884	59 943	[a] 850 000	[a] 11 000		[a] 1 250 000

[a] Estimated.

Table 5. Liquids received for disposal at commercial sites, 1962–1971[a]

Year	Quantity[b] (gallons)				
	Kentucky	Nevada	Washington	National annual total	National cumulative total
1962		128 000		128 000	128 000
1963	18 514	130 438		148 952	276 952
1964	31 624	41 145		72 769	349 721
1965	32 325	21 474	443	54 242	403 963
1966	22 047	52 030	616	74 693	478 656
1967	30 590	12 429	5 204	48 223	526 879
1968	55 497	32 325	2 813	90 635	617 514
1969	44 762	23 151	737	68 650	686 164
1970	20 009	7 790	666	28 465	714 629
1971	339 009	34 452	115	373 576	1 088 205
Total	594 377	483 234	10 594		1 088 205

[a] No liquids accepted at commercial sites for 1972–1973.
[b] Liquids never accepted in South Carolina, Illinois, or New York.

because of the economic considerations associated with transportation costs.

In figure 2, the unusually large increase in the total radioactivity buried at Kentucky in 1971, was due to a single package of tritium-contaminated waste (645 000 curies) from a Federal research facility. To relate the radioactivity buried to the volume of waste is difficult since the activity concentration in the waste depends upon the originating source and the use of radioactive material at the source. For nuclear power plants, the waste shipments have averaged 0.15 Ci/cubic foot from pres-

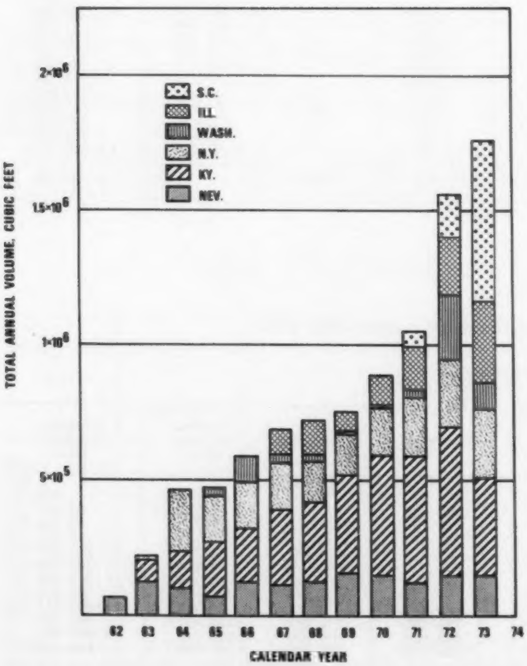

Figure 1. Total volume of radioactive wastes buried at commercial sites in the United States

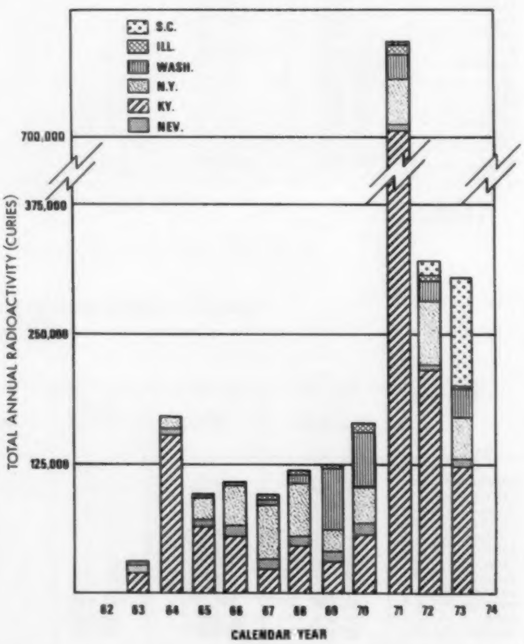

Figure 2. Total curies of byproduct material at commercial sites in the United States

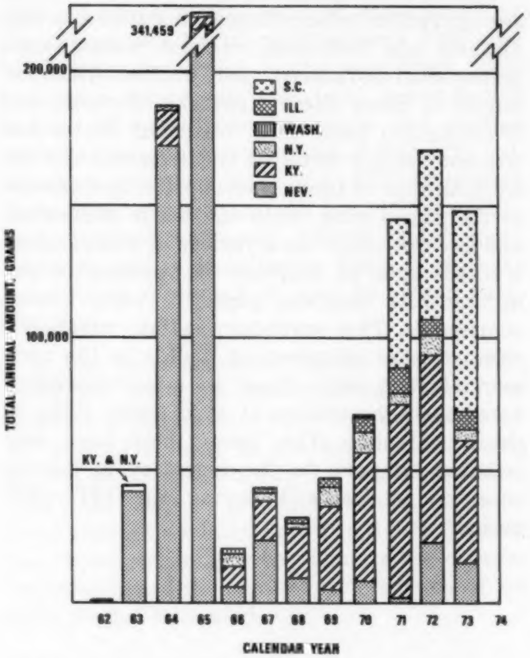

Figure 3. Total grams of special nuclear material buried at commercial sites in the United States

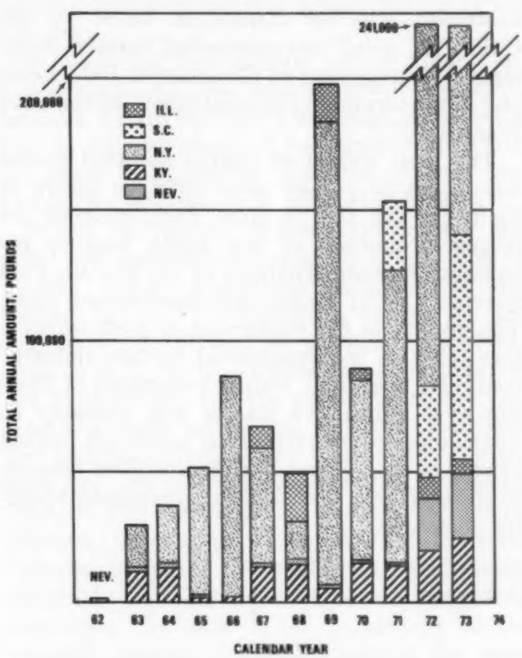

Figure 4. Total pounds of source material buried at commercial sites in the United States (Washington State data not included)

surized water reactors and 0.89 Ci/cubic foot from boiling water reactors (*6*).

The waste input to sites in the western United States (Nevada and Washington) has not been as large as the waste input to the other sites. This may reflect the fact that commercial nuclear power development in these regions has not been as rapid as elsewhere in the United States. Whereas the Kentucky, Illinois, New York, and South Carolina sites show either large quantities or increases in quantities from 1970 onward, probably because of the growth of nuclear power in these regions; the western sites have continued to receive lesser quantities of wastes at a level consistent with the steady contribution from isotope manufacturers, radiopharmaceutical firms, and research facilities. This trend is likely to change as nuclear power becomes more significant in the western United States.

Figure 3 illustrates the variable quantities of SNM being buried. Because this type of waste often contains significant quantities of transuranium elements (those elements with an atomic number greater than 92), it is expected that the future may show decreasing amounts of SNM at particular sites and perhaps increases at others. This shifting of the destination of transuranic-contaminated waste may well be the result of the exclusion of SNM wastes exceeding 10 nCi/g of transuranics at the three eastern sites. The prohibition of transuranic waste burial at the Barnwell, S.C. facility is part of the State license agreement made in 1971. As of 1974, the States of Kentucky and New York and their burial facility contractors have notified their customers that they will no longer accept transuranic wastes. In the near future, it is possible that all waste materials exceeding 10 nCi/g contamination

with transuranics will be taken to an AEC-controlled site for disposition based on the U.S. AEC draft environmental impact statement, "Management of Commercial High Level and Transuranium-Contaminated Radioactive Waste". (*7*).

The total weight of source material buried has increased greatly since 1968, as shown in figure 4. The site in New York receives the largest proportion of this waste, possibly because of the close proximity of the Nuclear Fuel Services (NFS) nuclear fuel reprocessing plant. The growth in the production of such waste is inevitable as the commercial nuclear industry continues to expand. Future generation of these low-level radioactive wastes will probably be distributed to the burial sites which are located closest to the various nuclear facilities because of the economic advantage of minimizing trucking distances.

Figure 5 demonstrates the impact on burial site operations when changes in burial site regulations are instituted. Liquid wastes were transported and stored onsite until solidified for burial at three sites (Kentucky, Nevada, and Washington) until 1972, when the States and site contractors initiated requirements for the solidification of these wastes prior to shipment to the burial sites. Both the waste generators and site operators use a variety of solidification methods such as sorption on vermiculite and mixing with concrete, paper, or other special compounds. This regulatory action, which will eliminate the shipment of liquids to the commercial sites may result in a corresponding increase in the volume of solid waste going to the burial sites. This factor may have contributed, in part, to the increases in volume observed in figure 1 during the 1971–1973 period.

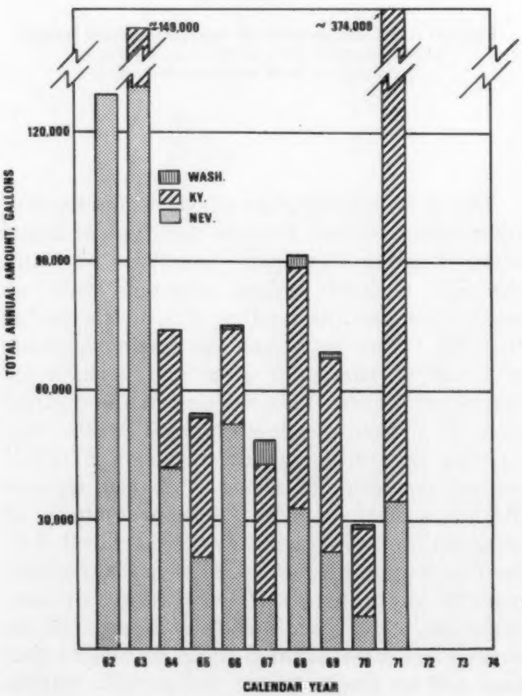

Figure 5. Total gallons of liquid wastes received at commercial sites in the United States

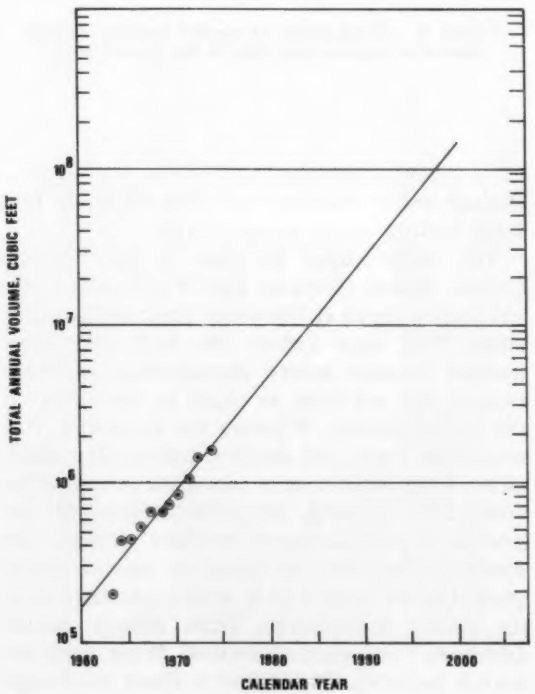

Figure 6. Volume of solid wastes buried annually

Figure 6 contains a plot of the national annual volumes (from table 1) of waste buried at the commercial burial sites between 1963 and 1973 and a projection to the year 2000. This projection represents the total uncompacted volume of waste from fuel cycle and nonfuel cycle sources and is extrapolated from the volume buried between 1963 and 1973 rather than from nuclear power growth projections. However, the nuclear power growth factor is included in the regionalization and site capacity projections discussed in the following paragraphs.

It has been estimated by the years, 1980, 1985, and 2000, the uncompacted waste from nonfuel cycle sources will be approximately 44, 27, and 14 percent of the total wastes being buried as low-level waste for each respective year (*8*). Table 6 presents average values of the projected volumes shown in figure 6, using the above percentages to calculate the average contribution of the nonfuel cycle portion of the total wastes estimated.

Table 6. Projected average annual volume of low-level waste (10^6 cubic feet/yr)

Type	1976–1980	1981–1990	1991–2000
Fuel cycle waste	2.0	10.6	68.0
Nonfuel cycle waste[a]	1.6	3.9	11.0
Total[b]	3.6	14.5	79.0

[a] From reference *8*.
[b] From figure 6.

Regionalization and site capacities

Although previous projections have been made of the quantity of low-level waste that will result from the fuel cycle and nonfuel cycle sources, no previous attempt has been made to relate the projections to the available capacity of the commercial sites. Therefore, a number of suppositions are made in the following paragraphs to speculate on what the impact might be on the present commercial burial sites if the projections indicated previously become valid. By arbitrarily dividing the continental United States into six geographic regions, and assuming that nuclear facilities within the region will send their radioactive waste to the regional burial ground, it is possible to allocate the national projected volume among the six existing sites.

In allocating the national annual volume of waste (table 6), the nuclear power electrical capacity within the region was used as the basis for the regional share of fuel cycle wastes, and an equal geographical distribution was assumed for nonfuel cycle generated wastes.

Based on reactor license applications, the AEC has periodically published projections of nuclear power generating capacity for the United States (*9*). Figure 7, shows the six regions which are used for the projected allocations to each of the six sites. These boundaries are hypothetical and the assumptions and calculations made within this section do not have any political or regulatory significance. To extend the waste generation estimates beyond 1985, it was assumed that the nuclear plants planned beyond the 1985 AEC projections (shown in figure 7) would not significantly affect the relative regional power generating capacities. In table 7, the percentage of the national nuclear electrical capacity for each region is given, and the projected total annual volume of waste the region can expect to generate during the indicated time period is given in parentheses. The estimated annual volume includes both fuel cycle and nonfuel cycle generated wastes. Based on this assumption, it is possible to estimate the cumulative

Table 7. Regional percentage of national nuclear power capacity and estimated annual low-level radioactive waste generated in the region in the time period indicated

Region	Site	Volume (10^6 cubic feet/yr) 1976–1980	1981–1990	1991–2000
Northeastern	West Valley, N.Y.	24% (0.7)	23% (3.1)	23% (17.4)
Middle Atlantic	Maxey Flats, Ky	16% (.6)	13% (2.0)	13% (10.7)
Southern	Barnwell, S.C	27% (.8)	28% (3.6)	28% (20.8)
Midwestern	Sheffield, Ill	23.5% (.7)	26.5% (3.5)	26.5% (19.9)
Southwestern	Beatty, Nev	5% (.4)	5.5% (1.2)	5.5% (5.6)
Northwestern	Richland, Wash	4.5% (.4)	4% (1.1)	4% (4.6)

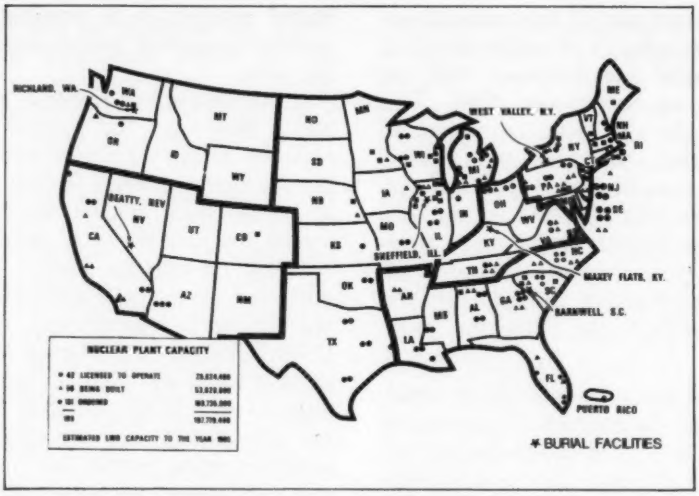

Figure 7. Location of commercial burial facilities and nuclear power reactors in the United States

volume of waste destined for each of the six arbitrary regions. This summation is presented in table 8.

Table 8. Estimated cumulative volume of waste generated in each region through the year indicated

Region	Volume (10^6 cubic feet)				
	1973[a]	1975[b]	1980[c]	1990[c]	2000[c]
Northeastern	2.0	2.9	6.4	37.4	211.4
Middle Atlantic	3.4	4.9	7.9	27.9	134.9
Southern	.8	1.1	5.1	41.1	249.1
Midwestern	1.0	1.4	4.9	39.5	238.5
Southwestern	1.5	2.1	4.1	16.1	72.1
Northwestern	.5	.7	2.7	13.7	59.7
National cumulative total	9.2	13.1	31.1	175.7	965.7

[a] Obtained from table 1.
[b] Calculated using figure 6 and the partitioning of waste based upon cumulative volume up to 1973.
[c] Obtained from table 7.

It is possible that the existing sites may not be able to satisfy the demand within each region. Therefore, a further assumption is made concerning the trench capacity and the estimated waste generation rate. A standard trench is assumed to be 300 feet long x 40 feet wide x 20 feet deep (240 000 cubic feet) with 20 feet of spacing between adjacent trenches. This standard trench will not be 100 percent filled with waste, but will contain voids. It is assumed that the top meter of the trench depth will not be used and that a 30 percent void space will exist for each trench, thereby reducing the effective burial volume to approximately 143 000 cubic feet per trench. Table 9 summarizes the capacities of the existing sites using the foregoing assumptions and the date by which their current capacity will be exhausted using the cumulative regional volumes from table 8.

Table 9. Regional site sizes, burial capacity, and date by which current capacity may be exhausted

Site	Size (acres)	Possible number of standard trenches onsite	Current burial capacity (cubic feet)	Date current capacity may be exhausted
West Valley, N.Y.	22	50	7.2×10^6	1981
Maxey Flats, Ky.	330	750	1.1×10^8	1998
Barnwell, S.C.	270	614	8.8×10^7	1993
Sheffield, Ill.	22	50	7.2×10^6	1981
Beatty, Nev.	80	182	2.6×10^7	1992
Richland, Wash.	100	227	3.2×10^7	1994

The operational lifetime of each site depends upon the rate at which waste is received, site

size, land availability for site expansion, and operational practices. The results, as shown in table 9, indicate that the current burial capacity of all six existing sites will be filled by 1998. Therefore, based on the waste generation rate projection, the existing sites will have to be closed or enlarged, or new sites will have to be established if enlargement is not possible because of geographical, topographical, or geological limitations.

Reducing the volume of the estimated wastes to be buried by compaction is one method available for extending the usefulness of a site. From a report describing AEC-managed waste, a reduction in volume by a factor from 3 to 5 is possible (*10*). Therefore, if such volume reduction methods were instituted on all waste being sent to these burial sites, only two facilities, West Valley and Sheffield, would be filled before the year 2000.

Conclusion

The primary purpose of this report is to present the inventory data accumulated by this agency during the past few years, to point out some of the more obvious trends, and to identify and focus attention on the possible magnitude of the low-level radioactive waste disposal problem with which we may be faced in the near future. The data presented indicate that the volume and quantity of low-level waste is growing rapidly.

Based on these data, the assumptions, estimates and projections made about the existing commercial burial facilities indicate that two of the sites could be filled by 1985 and all six of the present sites could be filled by 1998 if no changes to the present practices or trends occur. Therefore, indicate that since a significant time period will be required for planning, evaluation, and licensing of any new burial sites, or for any significant expansion of existing sites, it is imperative that a more detailed analysis of low-level waste management activities than attempted in this report be completed.

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REFERENCES

(*1*) MORTON, R. Land burial of solid radioactive wastes: study of commercial operations and facilities, WASH-1143. U.S. Atomic Energy Commission (1968).

(*2*) FRY, R. M. Radioactive waste disposal. Amer J Pub Health 59:448–450 (March 1969).

(*3*) CLARK, D. T. A history and preliminary inventory report on the Kentucky radioactive waste disposal site. Radiat Data Rep 14:573–585 (October 1973).

(*4*) Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation."

(*5*) U.S. ATOMIC ENERGY COMMISSION. Licensing statistics and other data, U.S. Atomic Energy Commission and the Agreement States (June 1973).

(*6*) U.S. ATOMIC ENERGY COMMISSION. Report of releases of radioactivity in effluents and solid waste from nuclear power plants for 1972. U.S. Atomic Energy Commission, Directorate of Regulatory Operations (August 1973).

(*7*) U.S. ATOMIC ENERGY COMMISSION. Management of commercial high level and transuranium—contaminated radioactive waste, WASH-1539. U.S. Atomic Energy Commission draft environmental statement (September 1974).

(*8*) BLOMEKE, J. O. Projections of future requirements in waste management. Presented at the Health Physics Society Annual Meeting, New York (July 1971).

(*9*) U.S. ATOMIC ENERGY COMMISSION. U.S. AEC news release, Vol. 5 (November 5, 1973).

(*10*) U.S. ATOMIC ENERGY COMMISSION. Compaction of radioactive solid wastes, WASH-1167. U.S. Atomic Energy Commission (June 1970).

SECTION I. MILK AND FOOD

Milk Surveillance, July 1974

Although milk is only one of the sources of dietary intake of environmental radioactivity, it is the food item that is most useful as an indicator of the general population's intake of radionuclide contaminants resulting from environmental releases. Fresh milk is consumed by a large segment of the population and contains several of the biologically important radionuclides that may be released to the environment from nuclear activities. In addition, milk is produced and consumed on a regular basis, is convenient to handle and analyze, and samples representative of general population consumption readily can be obtained. Therefore, milk sampling networks have been found to be an effective mechanism for obtaining information on current radionuclide concentrations and long-term trends. From such information, public health agencies can determine the need for further investigation or corrective public health action.

The Pasteurized Milk Network (PMN) sponsored by the Office of Radiation Programs, Environmental Protection Agency, and the Office of Food Sanitation, Food and Drug Administration, Public Health Service, consists of 65 sampling stations: 63 located in the United States, one in Puerto Rico, and one in the Canal Zone. Many of the State health departments also conduct local milk surveillance programs which provide more comprehensive coverage within the individual State. Data from 15 of these State networks are reported routinely in *Radiation Data and Reports*. Additional networks for the routine surveillance of radioactivity in milk in the Western Hemisphere and their sponsoring organizations are:

Pan American Milk Sampling Program (Pan American Health Organization and U.S. Environmental Protection Agency)—5 sampling stations

Canadian Milk Network (Radiation Protection Division, Canadian Department of National Health and Welfare)—16 sampling stations.

The sampling locations that make up the networks reporting presently in *Radiation Data and Reports* are shown in figure 1. Based on the similar purpose for these sampling activities, the present format integrates the complementary data that are routinely obtained by these several milk networks.

Radionuclide and element coverage

Considerable experience has established that relatively few of the many radionuclides that are formed as a result of nuclear fission become incorporated in milk (*1*). Most of the possible radiocontaminants are eliminated by the selective metabolism of the cow, which restricts gastrointestinal uptake and secretion into the milk. The five fission-product radionuclides which commonly occur in milk are strontium-89, strontium-90, iodine-131, cesium-137, and barium-140. A sixth radionuclide, potassium-40, occurs naturally in 0.0118 percent (*2*) abundance of the element potassium, resulting in a specific activity for potassium-40 of 830 pCi/g total potassium.

Two stable elements which are found in milk, calcium and potassium, have been used as a means for assessing the biological behavior of

Figure 1. Milk sampling networks in the Western Hemisphere

metabolically similar radionuclides (radiostrontium and radiocesium, respectively). The contents of both calcium and potassium in milk have been measured extensively and are relatively constant. Appropriate values and their variations, expressed in terms of 2 standard deviations (2σ), for these elements are 1.16 ± 0.08 g/liter for calcium and 1.51 ± 0.21 g/liter for potassium. These figures are averages of data from the PMN for May 1963–March 1966 (*3*) and are used for general radiation calculations.

Accuracy of data from various milk networks

In order to combine data from the international, national, and State networks considered in this report, first it was necessary to determine the accuracy with which each laboratory is making its determinations and the agreement of the measurements among the laboratories. The Analytical Quality Control Service of the Research and Development Programs conducts periodic studies to assess the accuracy of determinations of radionuclides in milk performed by interested radiochemical laboratories. The generalized procedure for making such a study has been previously outlined (*4*).

The most recent study was conducted during June 1972 with 37 laboratories participating in an experiment on a milk sample containing known concentrations of iodine-131, cesium-137, strontium-89, and strontium-90 (*5*). Of the 18 laboratories producing data for the network reported in *Radiation Data and Reports,* 14 participated in the study.

The accuracy results of this study for these 14 laboratories are shown in table 1. The accuracy of the cesium-137 measurements continues to be excellent as in previous experiments. However, both the accuracy and precision need to be improved for iodine-131, strontium-89, and strontium-90 which could probably be accomplished through recalibration.

Development of a common reporting basis

Since the various networks collect and analyze samples differently, a complete understanding of several parameters is useful for interpreting the data. Therefore, the various milk surveillance networks that report regularly were surveyed for information on analytical methods, sampling and analysis frequencies, and estimated analytical errors associated with the data.

In general, radiostrontium is collected by an ion-exchange technique and determined by beta-particle counting in low-background detectors, and the gamma-ray emitters (potassium-40, iodine-131, cesium-137, and barium-140) are determined by gamma-ray spectroscopy of whole milk. Each laboratory has its own modifications and refinements of these basic methodologies.

Many networks collect and analyze samples on a monthly basis. Some collect samples more frequently but composite the several samples for one analysis, while others carry out their analyses more often than once a month. Many networks are analyzing composite samples on a quarterly basis for certain nuclides. The frequency of collection and analysis varies not only

Table 1. Distribution of mean results, quality control experiment

Isotope and known concentration		Number of laboratories in each category				Experimental 2σ error (pCi/liter)
		Acceptable [a]	Warning level [b]	Unacceptable [c]	Total	
Iodine-131:	(96 or 99 pCi/liter)	7 (58%)	1 (8%)	4 (33%)	12	6
	(438 or 484 pCi/liter)	11 (85%)	0	2 (15%)	13	25 or 28
Cesium-137:	(53 or 54 pCi/liter)	11 (92%)	0	1 (8%)	12	6
	(295 or 303 pCi/liter)	11 (85%)	2 (15%)	0	13	17
Strontium-89:	(29 or 30 pCi/liter)	9 (82%)	0	2 (18%)	11	6
	(197 or 201 pCi/liter)	3 (33%)	1 (11%)	5 (56%)	9	11 or 12
Strontium-90:	(32.1 or 32.4 (pCi/liter)	4 (33%)	4 (33%)	4 (33%)	12	1.9
	(150.5 or 151.2 pCi/liter)	6 (55%)	0	5 (45%)	11	8.7

[a] Measured concentration equal to or within 2σ of the known concentration.
[b] Measured concentration outside 2σ and equal to or within 3σ of the known concentration.
[c] Measured concentration outside 3σ of the known concentration.

among the networks but also at different stations within some of the networks. In addition, the frequency of collection and analysis is a function of current environmental levels. The number of samples analyzed at a particular sampling station under current conditions is reflected in the data presentation. Current levels for strontium-90 and cesium-137 are relatively stable over short periods of time, and sampling frequency is not critical. For the short-lived radionuclides, particularly iodine-131, the frequency of analysis is critical and generally is increased at the first measurement or recognition of a new influx of this radionuclide.

The data in table 2 show whether raw or pasteurized milk was collected. An analysis (*6*) of raw milk and pasteurized milk samples collected during January 1964 to June 1966 indicated that for relatively similar milkshed or sampling areas, the differences in concentration of radionuclides in raw and pasteurized milk are not statistically significant (*6*). Particular attention was paid to strontium-90 and cesium-137 in that analysis.

Practical reporting levels were developed by the participating networks, most often based on 2-standard-deviation counting errors or 2-standard deviation total analytical replicate analyses (*3*). The practical reporting level reflects analytical factors other than statistical radioactivity counting variations and will be used as a practical basis for reporting data.

The following practical reporting levels have been selected for use by all networks whose practical reporting levels were given as equal to or less than the given value.

Radionuclide	Practical reporting level (pCi/liter)
Strontium-89	5
Strontium-90	2
Iodine-131	10
Cesium-137	10
Barium-140	10

Some of the networks gave practical reporting levels greater than those above. In these cases, the larger value is used so that only data considered by the network as meaningful will be presented. The practical reporting levels apply to the handling of individual sample determinations. The treatment of measurements equal to or below those practical reporting levels for calculation purposes, particularly in calculating monthly averages, is discussed in the data presentation.

Analytical error of precision expressed as pCi/liter or percent in a given concentration range also has been reported by the networks (*3*). The precision errors reported for each of the radionuclides fall in the following ranges:

Radionuclide	Analytical errors of precision (2 standard deviations)
Strontium-89	1–5 pCi/liter for levels <50 pCi/liter; 5–10% for levels ≥ 50 pCi/liter;
Strontium-90	1–2 pCi/liter for levels <20 pCi/liter; 4–10% for levels ≥ 20 pCi/liter;
Iodine-131, Cesium-137, Barium-140	4–10 pCi/liter for levels <100 pCi/liter; 4–10% for levels ≥ 100 pCi/liter.

For iodine-131, cesium-137, and barium-140, there is one exception for these precision error ranges: 25 pCi/liter at levels <100 pCi/liter for Colorado. This is reflected in the practical reporting level for the Colorado milk network.

Federal Radiation guidance applicable to milk surveillance

In order to place the United States data on radioactivity in milk in perspective, a summary of the guidance provided by the Federal Radiation Council for specific environmental conditions was presented in the February 1973 issue of *Radiation Data and Reports*.

Data reporting format

Table 2 presents the integrated results of the international, national, and State networks discussed earlier. Column 1 lists all the stations which are reported routinely in *Radiation Data and Reports*. The relationship between the PMN stations and the State stations is shown in figure 2. The first column in table 2 under each of the reported radionuclides gives the

Table 2. Concentrations of radionuclides in milk for July 1974 and 12-month period, August 1973 through July 1974

Sampling location		Type of sample [a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average [b]	12-month average	Monthly average [b]	12-month average
UNITED STATES:						
Ala:	Montgomery [c]	P	4	4	11	2
Alaska:	Palmer [c]	P	NS	NA	NS	3
Ariz:	Phoenix [c]	P	0	0	0	1
Ark:	Little Rock [c]	P	9	9	16	5
Calif:	Los Angeles [c]	P	0	0	0	0
	Sacramento [c]	P	0	0	0	2
	San Francisco [c]	P	0	0	0	0
	Del Norte	P	12	9	0	4
	Fresno	P	0	1	0	0
	Humboldt	P	2	2	0	0
	Los Angeles	P	2	1	0	2
	Mendocino	P	0	2	0	2
	Sacramento	P	2	2	0	2
	San Diego	P	0	1	0	2
	Santa Clara	P	0	1	0	2
	Shasta	P	3	2	0	2
	Sonoma	P	2	2	0	3
Colo:	Denver [c]	P	3	3	11	1
	East	R	NS		NS	
	Northeast	R	NA		[d] 0	0
	Northwest	R	NA		[d] 0	0
	South Central	R	NS		NS	
	Southeast	R	NS		NS	0
	Southwest	R	NS		[d] 0	0
	West	R	NS		NS	0
Conn:	Hartford [c]	P	5	5	14	3
	Central	P	NA		NA	
Del:	Wilmington [c]	P	5	5	0	1
D.C:	Washington [c]	P	5	5	0	1
Fla:	Tampa [c]	P	NS		NS	24
	Central	R	NA		NA	
	North	R	NA		NA	
	Northeast	R	NA		NA	
	Southeast	R	NA		NA	
	Tampa Bay area	P	NA		NA	
	West	R	NA		NA	
Ga:	Atlanta [c]	P	5	5	14	4
Hawaii:	Honolulu [c]	P	0	0	0	0
Idaho:	Idaho Falls [c]	P	3	3	0	0
Ill:	Chicago [c]	P	6	6	15	1
Ind:	Indianapolis [c]	P	5	5	12	3
	Central	P	8	5	15	5
	Northeast	P	8	6	10	10
	Northwest	P	8	7	15	8
	Southeast	P	7	6	10	8
	Southwest	P	9	7	0	5
Iowa:	Des Moines [c]	P	5	5	12	1
	Des Moines	P	5	4	0	0
	Iowa City	P	7	6	0	0
	LeMars	P	4	4	0	0
	Little Cedar	P	8	6	0	0
Kans:	Wichita [c]	P	7	7	0	2
	Coffeyville	P	8	6	NA	7
	Dodge City	P	3	4	NA	7
	Falls City, Nebr	R	3	5	NA	8
	Hays	P	7	6	NA	5
	Kansas City	P	0	4	NA	5
	Topeka	P	4	6	NA	6
Ky:	Louisville [c]	P	4	4	11	4
La:	New Orleans [c]	P	9	9	12	6
Maine:	Portland [c]	P	6	6	20	11
Md:	Baltimore [c]	P	5	5	13	4
Mass:	Boston [c]	P	8	8	18	4
Mich:	Detroit [c]	P	6	6	12	4
	Grand Rapids [c]	P	8	8	13	1
	Bay City	P	12	10	0	3
	Charlevoix	P	11	9	0	0
	Detroit	P	4	9	13	1
	Grand Rapids	P	13	14	0	5
	Lansing	P	7	11	0	3
	Marquette	P	11	12	19	6
	Monroe	P	10	13	0	2
	South Haven	P	9	14	0	2
Minn:	Minneapolis [c]	P	9	9	15	1
	Bemidji	P	7	10	0	0
	Duluth	P	23	15	34	15
	Fergus Falls	P	5	6	0	0
	Little Falls	P	23	17	43	45
	Mankato	P	5	5	0	0
	Marshall	P	NS	3	NS	0

See footnotes at end of table.

Table 2. Concentrations of radionuclides in milk for July 1974 and 12-month period, August 1973 through July 1974—continued

Sampling location		Type of sample [a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average [b]	12-month average	Monthly average [b]	12-month average
Minn:	Minneapolis	P	8	9	0	0
	Rochester	P	6	6	0	0
Miss:	Jackson [c]	P	7	7	12	3
Mo:	Kansas City [c]	P	3	3	0	0
	St. Louis [c]	P	5	5	13	2
Mont:	Helena [c]	P	0	0	0	0
Nebr:	Omaha [c]	P	4	4	0	1
Nev:	Las Vegas [c]	P	0	0	0	0
N.H:	Manchester [c]	P	8	8	20	5
N.J:	Trenton [c]	P	NS	NA	NS	1
N. Mex:	Albuquerque [c]	P	0	0	0	0
N.Y:	Buffalo [c]	P	4	4	0	0
	New York City [c]	P	9	9	11	2
	Syracuse [c]	P	5	5	15	4
	Albany	P	7	5	0	0
	Buffalo	P	9	5	0	0
	Massena	P	10	7	17	0
	New York City	P	NA	6	0	0
	Syracuse	P	13	6	11	0
N.C:	Charlotte [c]	P	5	5	0	4
	Asheville	P	7		0	
	Charlotte	P	7		0	
	Lexington	P	NA		NA	
	New Bern	P	7		0	
	Raleigh	P	7		0	
	Wilkesboro	P	11		21	
N. Dak:	Minot [c]	P	7	7	0	1
Ohio:	Cincinnati [c]	P	7	7	11	4
	Cleveland [c]	P	5	5	0	0
Okla:	Oklahoma City [c]	P	7	7	0	1
Oreg:	Portland [c]	P	0	0	0	0
	Coos Bay	P	NA		[d] 0	0
	Eugene	P	NA		15	5
	Medford	P	NA		[d] 0	0
	Portland composite	P	NA		[d] 0	0
	Portland local	P	NA		[d] 0	1
	Redmond	P	NA		[d] 0	3
	Tillamook	P	NA		[d] 0	5
Pa:	Philadelphia [c]	P	5	5	0	1
	Pittsburgh [c]	P	8	8	0	2
	Dauphin	P	5	4	0	0
	Erie	P	6	6	0	0
	Philadelphia	P	5	5	0	0
	Pittsburgh	P	8	6	0	0
R.I:	Providence [c]	P	5	5	19	6
S.C:	Charleston [c]	P	5	5	14	8
	Anderson–01	R	NS	7	NS	2
	Anderson–02	R	NS	6	NS	3
	Chapin	R	8	7	0	8
	Clemson	R	NS	7	NS	4
	Columbia	R	8	8	0	10
	Fairfield	R	7	6	0	11
	Hartsville–02	R	NS	6	NS	10
	Hartsville–03	R	NS	13	NS	13
	Lee County	R	NS	7	NS	10
	Oconee County	R	NS	7	NS	5
	Pickens	R	NS	7	NS	9
	Williston	R	NS	7	NS	15
	Winnsboro	R	6	6	12	14
	York–01	R	NS	7	NS	5
	York–02	R	NS	5	NS	0
S. Dak:	Rapid City [c]	P	NS	NA	NS	0
Tenn:	Chattanooga [c]	P	6	6	11	4
	Knoxville [c]	P	6	6	0	3
	Memphis [c]	P	4	4	0	2
	Chattanooga	P	5	7	0	1
	Clinton	R	9	10	0	3
	Fayetteville	R	6	8	0	4
	Kingston	R	10	9	0	3
	Knoxville	P	11	9	0	4
	Lawrenceburg	R	27	9	0	0
	Nashville	P	8	8	0	0
	Pulaski	R	9	7	0	0
	Sequoyah	R	NS	9	NS	0
Tex:	Austin [c]	P	0	0	0	0
	Dallas [c]	P	5	5	0	1
Utah:	Salt Lake City [c]	P	0	0	0	0
Vt:	Burlington [c]	P	7	7	13	3
Va:	Norfolk [c]	P	5	5	0	1
Wash:	Seattle [c]	P	4	4	0	3
	Spokane [c]	P	5	5	11	1

See footnotes at end of table.

Table 2. Concentrations of radionuclides in milk for July 1974 and 12-month period, August 1973 through July 1974—continued

Sampling location		Type of sample [a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average [b]	12-month average	Monthly average [b]	12-month average
Wash:	Benton County	R	0	0	0	0
	Franklin County	R	NS	0	NS	0
	Longview	R	5	6	0	7
	Sandpoint, Idaho	R	4	5	0	1
	Skagit County	R	8	5	0	2
W. Va:	Charleston [c]	P	7	7	12	2
Wisc:	Milwaukee [c]	P	4	4	0	0
Wyo:	Laramie [c]	P	2	2	0	0
CANADA:						
Alberta:	Calgary	P	4	4	0	5
	Edmonton	P	5	5	0	8
British Columbia:						
	Vancouver	P	7	6	13	11
Manitoba:						
	Winnipeg	P	4	4	13	8
New Brunswick:						
	Moncton	P	6	6	NS	8
Newfoundland:						
	St. John's	P	9	10	10	12
Nova Scotia:						
	Halifax	P	6	6	0	7
Ontario:	Ottawa	P	4	4	0	5
	Sault Ste. Marie	P	8	8	19	13
	Thunder Bay	P	6	6	13	9
	Toronto	P	3	4	0	5
	Windsor	P	3	2	NS	5
Quebec:	Montreal	P	4	5	0	4
	Quebec	P	7	7	0	12
Saskatchewan:						
	Regina	P	5	4	0	4
	Saskatoon	P	5	5	NS	5
CENTRAL AND SOUTH AMERICA:						
Canal Zone:						
	Cristobal [c]	P	0	0	0	0
Chile:	Santiago	P	NS	0	NS	3
Colombia:						
	Bogota	P	0	1	0	0
Ecuador:	Guayaquil	P	0	1	0	2
Jamaica:	Kingston	P	NS		NS	
Puerto Rico:						
	San Juan [c]	P	0	0	0	2
Venezuela:						
	Caracus	P	0	0	0	0
PMN network average [e]			4	4	6	2

[a] P, pasteurized milk.
R, raw milk.
[b] When an individual sampling result was equal to or less than the practical reporting level, a value of "0" was used for averaging. Monthly averages less than the practical reporting level reflect the fact that some but not all of the individual samples making up the average contained levels greater than the practical reporting level. When more than one analysis was made in a monthly period, the number of samples in the monthly average is given in parentheses.
[c] Pasteurized Milk Network station. All other sampling locations are part of the State or National network.
[d] The practical reporting level for this network differs from the general ones given in the text. Sampling results for these networks were equal to or less than the following practical reporting levels:
Cesium-137: Colorado—25 pCi/liter; Oregon—15 pCi/liter.
[e] This entry gives the average radionuclide concentrations for the Pasteurized Milk Network stations denoted by footnote [c].
NA, no analysis.
NS, no sample collected.

monthly average for the station and the number of samples analyzed in that month in parentheses. When an individual sampling station result is equal to or below the practical reporting level for the radionuclide, a value of zero is used for averaging. Monthly averages are calculated using the above convention. Averages which are equal to or less than the practical reporting levels reflect the presence of radioactivity in some of the individual samples greater than the practical reporting level.

The second column under each of the radionuclides reported gives the 12-month average for the station as calculated from the preceding 12 monthly averages, giving each monthly average equal weight. Since the daily intake of radioactivity by exposed population groups, averaged over a year, constitutes an appro-

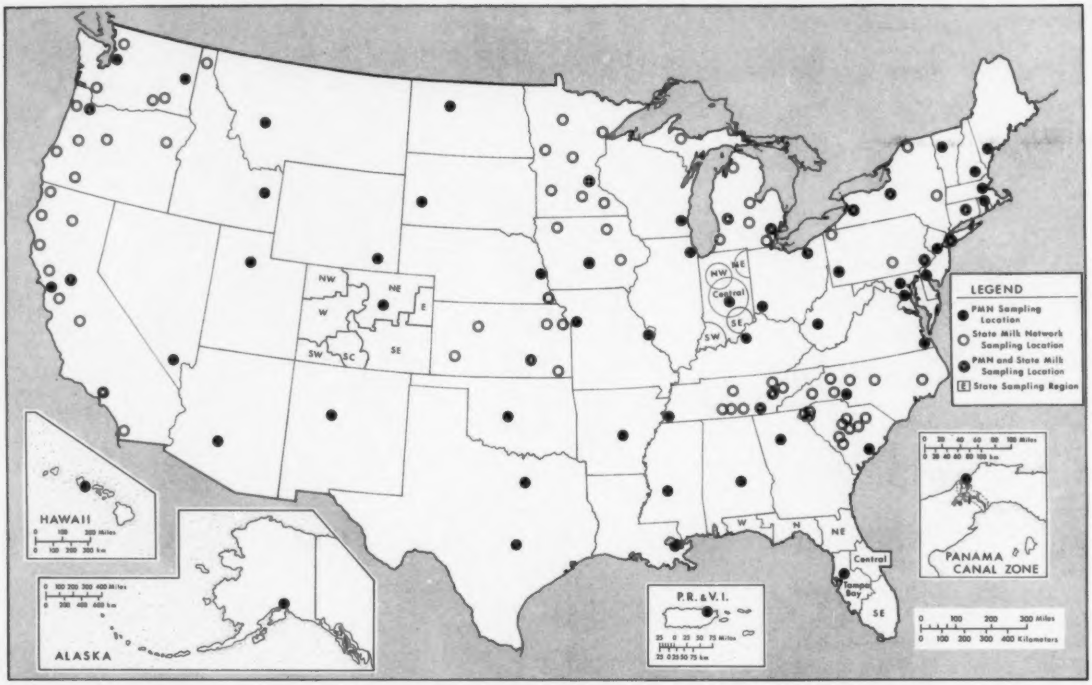

Figure 2. State and PMN sampling stations in the United States

priate criterion for the case where the FRC radiation protection guides apply, the 12-month average serves as a basis for comparison.

Discussion of current data

In table 2, surveillance results are given for strontium-90 and cesium-137 for July 1974 and the 12-month period, August 1973 to July 1974. Except where noted, the monthly average represents a single sample for the sampling station. Strontium-89, iodine-131, and barium-140 data have been omitted from table 2 since levels at all of the stations for June 1974 were below the respective practical reporting levels. The following station average reflects a sample in which strontium-89 was detected: Colombia: Bogota, 14 pCi/liter.

Strontium-90 monthly averages ranged from 0 to 27 pCi/liter in the United States for July 1974 and the highest 12-month average was 17 pCi/liter (Little Falls, Minn.) representing 8.5 percent of the Federal Radiation Council radiation protection guide. Cesium-137 monthly averages ranged from 0 to 43 pCi/liter in the United States for July 1974, and the highest 12-month average was 45 pCi/liter (Little Falls, Minn.) representing 1.3 percent of the value derived from the recommendations given in the Federal Radiation Council report.

The Office of Radiation Programs is in the process of modifying the milk program to make it more responsive to potential sources of environmental radioactivity. These changes will be reflected in the future.

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Colorado Department of Health

Laboratory Division
Connecticut Department of Health

Radiological and Occupational Health Section
Department of Health and Rehabilitative Services
State of Florida

Division of Radiological Health
Indiana State Board of Health

State Hygienic Laboratory
Medical Laboratories Building
Iowa City, Iowa

Radiation Control Program
Environmental Health Division
Kansas State Department of Health

Radiological Health Services
Division of Radiological Health
Michigan Department of Public Health

Radiation Control Section
Division of Environmental Health
State of Minnesota Department of Health

Bureau of Radiological Pollution Control
New York Department of Environmental Conservation

Radiation Protection Branch
Division of Facility Services
North Carolina Department of Human Resources

Radiological Control Section
Environmental Radiation Surveillance Program
Oregon Department of Human Resources

Radiological Health Section
Bureau of Radiological Health
Pennsylvania Department of Public Health

Division of Radiological Health
South Carolina Department of Health and Environmental Control

Division of Occupational and Radiological Health
Tennessee Department of Public Health

Radiation Control Unit
Division of Health
Washington Department of Social and Health Services

REFERENCES

(*1*) CAMBELL, J. E., G. K. MURTHY, A. S. GOLDIN, H. B. ROBINSON, C. P. STRAUB, F. J. WEBER, and K. H. LEWIS. The occurrence of strontium-90, iodine-131, and other radionuclides in milk, May 1957 through April 1958. Amer J Pub Health 49:225 (February 1969).

(*2*) U.S. ATOMIC ENERGY COMMISSION, DIVISION OF ISOTOPES DEVELOPMENT. Chart of the Nuclides, Tenth Edition revised to December 1968. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

(*3*) NATIONAL CENTER FOR RADIOLOGICAL HEALTH. Section I. Milk surveillance. Radiol Health Data Rep 9:730–746 (December 1968).

(*4*) ROSENSTEIN, M. and A. S. GOLDIN. Statistical technics for quality control of environmental radioassay. Health Lab Sci 2:93 (April 1965).

(*5*) BARATTA, E. J. and F. E. KNOWLES, JR. Interlaboratory study of iodine-131, cesium-137, strontium-89, and strontium-90 measurements in milk, June 1972, Technical experiment 72 MKAQ-1. Analytical Quality Control Service, Office of Radiation Programs, EPA, Washington, D.C. 20460 (December 1972).

(*6*) ROBINSON, P. B. A comparison of results between the Public Health Service Raw Milk and Pasteurized Milk Networks for January 1964 through June 1966. Radiol Health Data Rep 9:475–488 (September 1968).

Milk Surveillance Network,[1] Third Quarter 1974

National Environmental Research Center—
Las Vegas
Environmental Protection Agency

The Milk Surveillance Network, operated by the National Environmental Research Center—Las Vegas (NERC-LV) consists of 24 routine and 1 alternate sampling location (figure 1) situated in the offsite area surrounding the Nevada Test Site (NTS). This routine network is operated in support of the nuclear testing sponsored by the U.S. Atomic Energy Commission (AEC) at the Nevada Test Site (NTS).

In the event of a release of radioactivity from the NTS, special sampling within the affected area is conducted to determine radionuclide concentrations. Additional milk sampling net-

[1] This network is operated under a Memorandum of Understanding (No. AT(26–1)–539) with the Nevada Operations Office, U.S. AEC, Las Vegas, Nev.

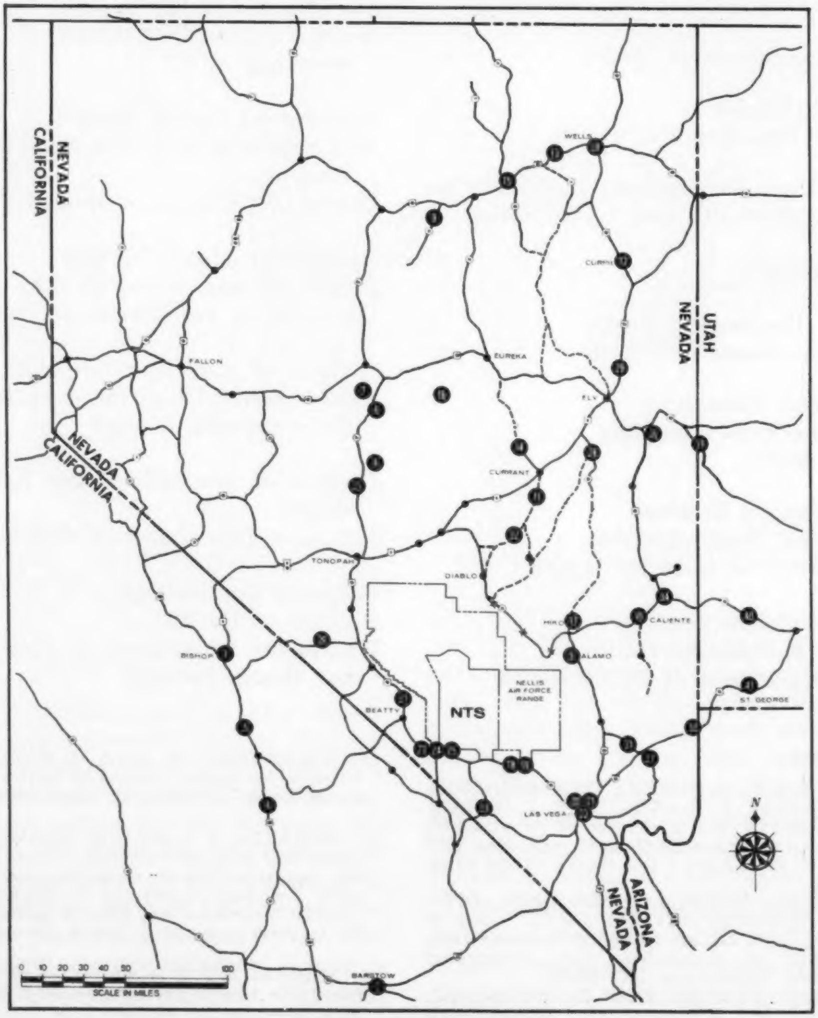

Figure 1. NERC-LV Milk Surveillance Network

works are operated in support of AEC operations in areas other than the NTS when requested. A complete description of sampling and analytical procedures was included with the milk results reported in the July 1973 issue of *Radiation Data and Reports.*

Results

The analytical results of all milk samples collected in the third quarter of 1974 by NERC-LV are listed in table 1. With the exception of cesium-137 at levels near the minimum detectable concentration (MDC) of 10 pCi/liter, no gamma-emitting fission products were identified by gamma spectrometry in any of the samples collected in the third quarter. Levels of tritium near the MDC for this radionuclide (200 pCi/liter) were also measured by liquid scintillation counting techniques. The highest concentrations of cesium-137 and tritium during the third quarter were 25 pCi/liter and 560 ± 230 pCi/liter, respectively.

Table 1. Milk surveillance results, July-September 1974

Location	Date collected (1974)	Sample type [a]	Radionuclide concentrations [b] (pCi/liter)			
			Cesium-137	Strontium-89	Strontium-90	Tritium
California:						
Bishop:						
Sierra Creamery	7/2	11	<10	<2.0	<1.2	NA
Hinkley:						
Bill Nelson Dairy	7/2	12	<10	<1.8	1.4 ±1.0	NA
Olancha:						
Hunter Ranch	7/2	13	<10	<1.9	<1.1	NA
Nevada:						
Alamo:						
Williams Dairy	7/10	12	<10	<1.6	<1.0	NA
Austin:						
Young's Ranch	7/16	13	<10	<2.0	<1.5	560±230
Currant:						
Blue Eagle Ranch	7/10	13	25	<1.8	1.1 ±1.1	NA
Manzonie Ranch	7/11	13	<10	<2.1	1.6 ±1.3	NA
Hiko:						
Schofield Dairy	7/10	12	<10	<1.8	<1.1	430±230
Indian Springs:						
Indian Springs Ranch	NS					
Las Vegas:						
LDS Dairy Farms	7/2	12	<10	<1.4	1.7 ±1.1	270±210
Lathrop Wells:						
Kirker Ranch	7/19	13	<10	<2.0	<1.1	NA
Lida:						
Lida Livestock Company	7/15	13	<10	<2.0	<1.2	NA
Logandale:						
Vegas Valley Dairy	7/15	12	<10	<2.2	3.6 ±1.4	NA
Lund:						
McKenzie Dairy	7/17	12	<10	<2.0	<1.3	<220
Mesquite:						
Hughes Bros. Dairy	7/16	12	<10	<1.6	<1.0	<230
Moapa:						
Searles Dairy	7/15	12	<10	<1.7	<1.1	NA
Nyala:						
Sharp's Ranch	7/11	13	<10	<1.5	1.6 ±1.0	340±220
Pahrump:						
Burson Ranch	7/18	13	<10	<1.6	<1.0	NA
Panaca:						
Kenneth Lee Ranch	7/8	13	<10	<2.0	< .93	NA
Round Mountain:						
Berg Ranch	NS					
Shoshone:						
Kirkeby Ranch	7/15	13	<10	<2.3	3.8 ±1.5	NA
Springdale:						
Seidentopf Ranch	7/11	13	<10	<2.0	<1.2	NA
Utah:						
Cedar City:						
Western Gold Dairy	7/18	12	<10	<2.2	<1.4	NA
St. George:						
R. Cox Dairy	7/17	12	<10	<2.0	<1.3	NA

[a] 11—pasteurized milk.
12—raw milk from Grade A producer(s).
13—raw milk from family cow(s).
[b] Two-sigma counting error provided when available.
[c] Small sample size increased minimum detectable activity.
NA, no analysis.
NS, no sample.

Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates, along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Programs reported in *Radiation Data and Reports* are as follows:

Program	Period reported	Issue
California Diet	July 1971–December 1972	February 1974
Carbon-14 in Total Diet and Milk	1972–1973	November 1973

Strontium-90 in Tri-City Diets,[1] January-December 1973

Health and Safety Laboratory
U.S. Atomic Energy Commission

Estimates of the average intake of strontium-90 by New York City, Chicago, and San Francisco residents have been made by the Health and Safety Laboratory (*HASL*). These estimates were made by using measurements of the strontium-90 content of a large variety of foods purchased at the cities every 3 months and statistics on the average consumption of each food compiled by the U.S. Department of Agriculture in their 1955 Household Diet Survey (*1*). A detailed description of the aims and methods of the HASL diet sampling program along with a summary of the results obtained during the first 3 years of operation (1960–1963) was published earlier (*2*).

In 1968, two changes were made in the program. The first change was the suspension of the collection and analysis of foods purchased in Chicago. Previous experience had shown the levels of strontium-90 in the Chicago diet to be consistently between those of New York City and San Francisco. Thus, reasonable estimates of the dietary intake of strontium-90 in Chicago at any time can be made from the analyses of foods purchased in New York City and San Francisco.

The second change, revision of the estimates of the annual consumption of different diet components, was made because new information became available. This new information on the composition of the diet appeared in a preliminary report of the U.S. Department of Agriculture in their 1965 Household Diet Survey (*3*). The changes in the composition of the diet from

[1] Data from Fallout Program Quarterly Summary Report, HASL 276, 278, 281, 284. Available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22151.

Table 1. Average dietary consumption and strontium-90 intake in Tri-City diet, January-June 1973

Food category	Diet (kg/a)	Calcium (g/a)	Strontium-90: New York City February 1973		San Francisco March 1973		New York City May 1973		San Francisco June 1973	
			(pCi/kg)	(pCi/a)	(pCi/kg)	(pCi/a)	(pCi/kg)	(pCi/a)	(pCi/kg)	(pCi/a)
Dairy products	200	216.0	6.6	1 326	1.6	315	4.0	800	0.6	120
Fresh fruit	59	9.4	16.0	941	2.6	156	12.5	740	3.0	177
Fresh vegetables	48	18.7	11.7	564	2.2	103	15.3	733	4.7	224
Root vegetables	10	3.8	7.0	70	3.6	36	5.1	51	2.6	26
Potatoes	38	3.8	6.8	260	3.2	121	5.2	196	1.1	43
Macaroni	3	.6	4.2	13	3.2	10	4.2	12	2.7	8
Rice	3	1.1	1.4	4	2.0	6	3.0	9	.6	2
Fruit juices	28	2.5	3.1	86	1.8	49	2.8	79	1.3	38
Canned vegetables	22	4.4	6.6	145	4.5	100	10.1	222	4.4	97
Canned fruit	11	.6	1.1	13	1.9	21	.9	10	.6	7
Dried beans	3	2.1	5.9	18	19.4	58	9.9	30	6.3	19
Flour	34	6.5	5.6	190	3.7	126	5.0	168	3.3	112
Bakery products	44	53.7	4.0	177	3.0	134	4.6	203	2.4	105
Whole grain products	11	10.3	9.4	104	7.3	80	9.4	103	5.0	55
Fresh fish	8	7.6	.1	1	.4	3	.6	5	.4	3
Shell fish	1	1.6	1.0	1	.3	0	1.5	1	.6	1
Poultry	20	6.0	.7	15	.3	7	.6	11	.3	6
Meat	79	12.6	.4	33	ND		.6	44	.3	20
Eggs	15	8.7	1.4	21	.7	10	2.5	37	1.1	17
Annual intake (pCi/a)		370		3 982		1 335		3 454		1 080
Daily intake (pCi/g Ca)				10.8		3.6		9.3		2.9

ND, nondetectable.

Table 2. Average dietary consumption and strontium-90 intake in Tri-City diet, July-December 1973

Food category	Diet (kg/a)	Calcium (g/a)	Strontium-90: New York City August 1973		San Francisco September 1973		New York City November 1973		San Francisco December 1973	
			(pCi/kg)	(pCi/a)	(pCi/kg)	(pCi/a)	(pCi/kg)	(pCi/a)	(pCi/kg)	(pCi/a)
Dairy products	200	216.0	6.0	1 210	1.4	285	5.1	1 023	1.3	262
Fresh fruit	59	9.4	2.2	132	1.8	106	13.3	787	1.9	110
Fresh vegetables	48	18.7	9.7	465	1.9	90	15.5	745	2.1	99
Root vegetables	10	3.8	7.4	74	3.0	30	8.9	89	3.3	33
Potatoes	38	3.8	3.5	132	1.5	57	6.5	249	5.1	193
Macaroni	3	.6	3.5	10	2.9	9	3.4	10	2.5	7
Rice	3	1.1	1.0	3	1.7	5	1.4	4	1.3	4
Fruit juices	28	2.5	3.2	88	1.3	35	3.1	87	1.7	49
Canned vegetables	22	4.4	8.5	187	3.6	80	9.5	209	4.7	103
Canned fruit	11	.6	1.4	16	.9	9	1.1	12	.9	10
Dried beans	3	2.1	28.0	84	22.3	67	23.0	69	10.9	33
Flour	34	6.5	6.2	211	1.7	58	5.2	176	2.6	87
Bakery products	44	53.7	3.7	163	2.3	102	4.5	196	2.5	111
Whole grain products	11	10.3	7.3	81	6.0	66	7.8	86	4.2	46
Fresh fish	8	7.6	1.8	15	.2	1	.4	3	.6	5
Shell fish	1	1.6	.7	1	.4	—	1.4	1	.9	1
Poultry	20	6.0	.8	16	.4	9	.6	12	.5	10
Meat	79	12.6	.5	42	.3	21	.8	63	.4	35
Eggs	15	8.7	.6	9	.6	9	1.5	22	.9	14
Annual intake (pCi/a)		370		2 939		1 039		3 843		1 212
Daily intake (pCi/g Ca)				7.9		2.8		10.4		3.3

1955 to 1965 are not very great, and the estimates of strontium-90 intake made using statistics from either diet survey are not too different. Estimates of the intakes of other nuclides, however, may be affected to a greater degree. The new estimates of the consumption have therefore been used to calculate the intakes of calcium and strontium-90 for 1973 in New York City and San Francisco.

Results for January–December 1974 are presented in tables 1 and 2. The variation with time of the daily intake of strontium-90 in the three cities is plotted in figure 1.

REFERENCES

(*1*) U.S. DEPARTMENT OF AGRICULTURE. Food consumption of households in the United States, household food consumption survey, Report No. 1 (1955). Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 (December 1956).

(*2*) RIVERA, J. and J. H. HARLEY. HASL contributions to the study of fallout in food chains, HASL-137. Office of Technical Services, U.S. Atomic Energy Commission, New York, N.Y. (July 1, 1964).

(*3*) U.S. DEPARTMENT OF AGRICULTURE. Food consumption of households in the United States, spring 1965, A Preliminary Report. USDA, ARS 62-16 (August 1967).

Previous coverage in Radiation Data and Reports:

Period	Issue
January–December 1972	December 1973

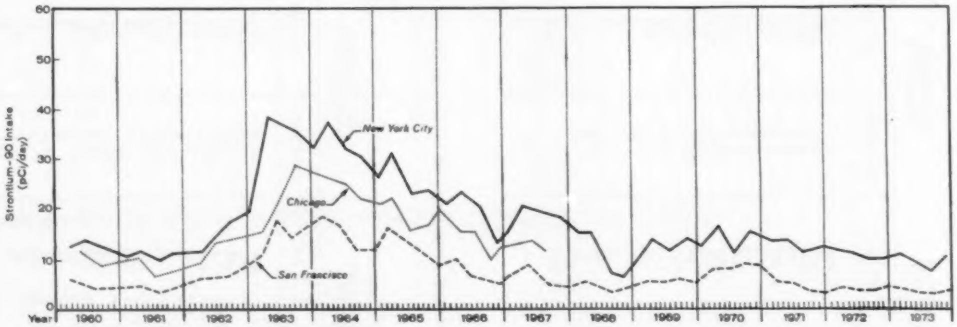

Figure 1. Daily intake of strontium-90 in tri-city diets, 1960-December 1973

SECTION II. WATER

The Environmental Protection Agency and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*) set the limits for approval of a drinking water supply containing radium-226 and strontium-90 at 3 pCi/liter and 10 pCi/liter, respectively. Higher concentrations may be acceptable if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence[1] of strontium-90 and alpha-particle emitters, the limit is 1000 pCi/liter gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities reported in *Radiation Data and Reports* are listed below.

[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

Water sampling program	Period reported	Issue
California	1971 and 1972	November 1973
Colorado River Basin	1968	March 1972
Community Water Supply Study	1969	September 1972
ERAMS Surface Water and Drinking Water Components	January–March 1974	August 1974
Florida	1970	April 1974
Kansas	1972	August 1974
Minnesota	July 1971–June 1972	March 1974
New York	1972	June 1974
North Carolina	1971	July 1974
Radiostrontium in Tap Water, *HASL*	1972	December 1973
Washington	July 1971–June 1972	October 1974

REFERENCES

(*1*) U.S. PUBLIC HEALTH SERVICE. Drinking water standards, revised 1962, PHS Publication No. 956. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 1963).

(*2*) FEDERAL RADIATION COUNCIL. Radiation Protection Guidance for Federal Agencies, Memorandum for the President, September 1961. Reprint from the Federal Register of September 26, 1961.

(*3*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 1. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 1960).

(*4*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1961).

Interstate Carrier Drinking Water Analysis Program, 1972

Office of Water Operations and
Office of Radiation Programs
Environmental Protection Agency

The routine surveillance of finished drinking water from public drinking water supplies is a project of the Office of Water Program Operations of the Environmental Protection Agency (EPA), in partial fulfillment of the requirements as set forth in Subpart J of the Interstate Quarantine Regulation (*1*) most commonly referred to as the Public Health Service Drinking Water Standards. The basic network for this activity is the approximately 700 water supplies (serving over half of the U.S. population with access to public water systems) which provide water for use by interstate carriers. Laboratory support is provided by the Eastern Environmental Radiation Facility and the Office of Radiation Programs—Las Vegas Facility. All samples were taken either as a single grab sample or composite samples taken over 12 to 14 days and the results of the radiological analyses are shown in table 1. In many cases where a water system receives raw water from more than one source, the finished drinking water derived from each source has been examined.

The drinking water standards for radionuclides are conservative in their requirements so that the total intake of these radionuclides from all sources is not likely to result in an intake greater than the guidance levels given by the Federal Radiation Council (*2*).

The standards provide for the approval of water supplies, based on their radionuclide content, when the water does not contain more than 3 pCi/liter of radium-226 nor 10 pCi/liter of strontium-90. In the absence of strontium-90 and alpha emitters, the water supply is acceptable when the gross beta concentration does not exceed 1000 pCi/liter.

However, a water supply may be approved when the limits prescribed above are exceeded if it can be demonstrated by surveillance that the total intake of radioactivity from all sources is within the guidance for control action recommended by the Federal Radiation Council. When mixtures of radionuclides are present, the relative contribution of each radionuclide to the total intake of the individual should be considered when evaluating the exposure.

Other coverage in Radiation Data and Reports:

Period	Issue
1961–1966	August 1968
1967–1969	December 1970
1970	July 1971
1971	May 1972

REFERENCES

(*1*) DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, PUBLIC HEALTH SERVICE. Federal Register Rules and Regulations, Title 42, Public Health Chapter 1, Part 72, Interstate Quarantine, Subpart J, Drinking Water Standards: 2154–2155 (March 6, 1962).

(*2*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, (September 1961).

Table 1. Radiological analysis of interstate carrier water supplies, 1972[a]

Sample location		Date collected (1972)	Gross alpha (pCi/liter ± 2σ)	Gross beta (pCi/liter ± 2σ)	Radium-226 (pCi/liter ± 2σ)	Strontium-90 (pCi/liter ± 2σ)
Ala:	Birmingham	8/17– 8/30	0	0		
		8/17– 8/30	0	2±1		
		8/31	0	0		
		8/18– 8/31	0	0		
		8/18– 8/31	0	4±1		
		8/18– 8/31	0	0		
		8/18– 8/31	0	0		
		8/31	0	0		
		8/31	0	0		
Colo:	Antonito	7/18	0	0		
Conn:	Bridgeport	8/ 7	0	5±1		
		8/ 7	0	5±1		
		8/ 8	0	4±1		
		8/ 8	0	3±1		
		8/8	0	3±1		
		8/ 8– 8/21	0	3±1		
		8/ 8– 8/21	0	0		
		8/ 8– 8/21	0	3±1		
		8/24	0	0		
	Danbury	9/27–10/10	0	3±1		
		9/27–10/11	0	0		
	Groton	6/ 8– 6/21	0	4±1		
	New Haven	11/14	0	0		
		11/14	0	0		
		11/14	0	0		
		11/13–11/26	0	3±1		
		11/13–11/26	0	0		
		11/14–11/27	0	0		
		11/14–11/27	0	2±1		
		11/14–11/27	0	0		
		11/20–12/ 3	0	3±1		
		11/20–12/ 3	0	2±1		
		11/20–12/ 3	0	4±1		
	New London	6/ 7– 6/20	0	5±1		
	Stamford	11/ 1–11/14	0	4±1		
		11/ 1–11/14	0	4±1		
	Waterbury	6/27– 7/10	0	4±1		
		6/27– 7/10	0	4±1		
	Windsor Locks	8/22	0	3±1		
		8/22	0	0		
		8/22	0	0		
		8/22	0	0		
Ill:	Bedford Park	5/ 8	0	3±1		
	Harrisburg	7/14	0	7±2		
	Hartford	7/12	0	4±1		
	Joilet	5/16	16±4	32±3	4.6±0.1	0
		5/17	12±6	25±3	2.7± .1	0
	Lemont	5/ 9	18±8	27±3	8.7± .1	0
	Orland Park	5/10	4±4	4±1		
	Peoria	7/11	0	8±2		
Ind:	East Chicago	12/13	0	4±1		
	Logansport	12/12	0	3±1		
Kans:	Wichita	9/26	0	4±3		
		9/26	0	0		
La:	Boothville	6/29– 7/11	0	6±3	.5± .2	
	Empire	6/28– 7/10	0	4±3	.5± .2	
Mich:	Marine City	11/9	0	3±1		
	Port Huron	11/8	0	2±1		
N.J:	North Cape May	9/21	0	7±2		
	Weehawken	4/ 4	0	3±1		
N. Mex:	Albuquerque	8/29	4±3	9±3	.4± .2	
		9/ 1	10±5	14±4		0
N. Mex:	Roswell	10/17	0	0		
		10/17	0	0		
		10/17	0	0		
N.Y:	Lockport	10/10	0	4±1		
	Niagara Falls	10/12	0	3±1		
	Oneonta	11/28	0	0		
	White Plains	11/ 6	0	0		
Ohio:	Canton	8/22	0	0		
	Cincinnati	11/ 6	0	4±1		
	Dayton	10/31	0	3±1		
	Gallipolis	8/23	0	0		
P.R:	Guayama	12/ 7	0	0		
	Penuelas	12/11	0	0		
	Ponce	12/12	0	0		
Tex:	Pasadena	8/10	0	0		
	Texas City	8/10	0	7±3		
Wash:	Bellingham	12/20	0	0		
	Ferndale	12/20	0	0		
	Longview	12/ 7	0	0		
Wash:	Port Angeles	7/26	0	0		
	Raymond	12/27	0	0		
Summary			0.8	3.2	[b] 2.9	[b] 0

[a] The minimum detectable radioactivity is 2 pCi/liter for strontium-90, gross alpha, and gross beta radioactivity; and 0.1 pCi/liter for radium-226. All values equal to or less than the minimal detectable radioactivity are reported as 0.

[b] Average of only those samples analyzed.

Water Surveillance Network, Third Quarter 1974

National Environmental Research Center—
Las Vegas
Environmental Protection Agency

The Water Surveillance Network,[1] operated by the National Environmental Research Center—Las Vegas (NERC-LV), consists of 59 sampling locations (figures 1 and 2) in the offsite area surrounding the Nevada Test Site (NTS). This routine network is operated in support of the nuclear testing sponsored by the U.S. Atomic Energy Commission (AEC) at the NTS.

In the event of a release of radioactivity from the NTS, special sampling within the affected area is conducted to determine radionuclide concentrations. Additional water sampling networks are operated in support of AEC operations in areas other than the NTS when re-

[1] This network is operated under a Memorandum of Understanding (No. AT(26-1)-539) with the Nevada Operations Office, U.S. AEC, Las Vegas, Nev.

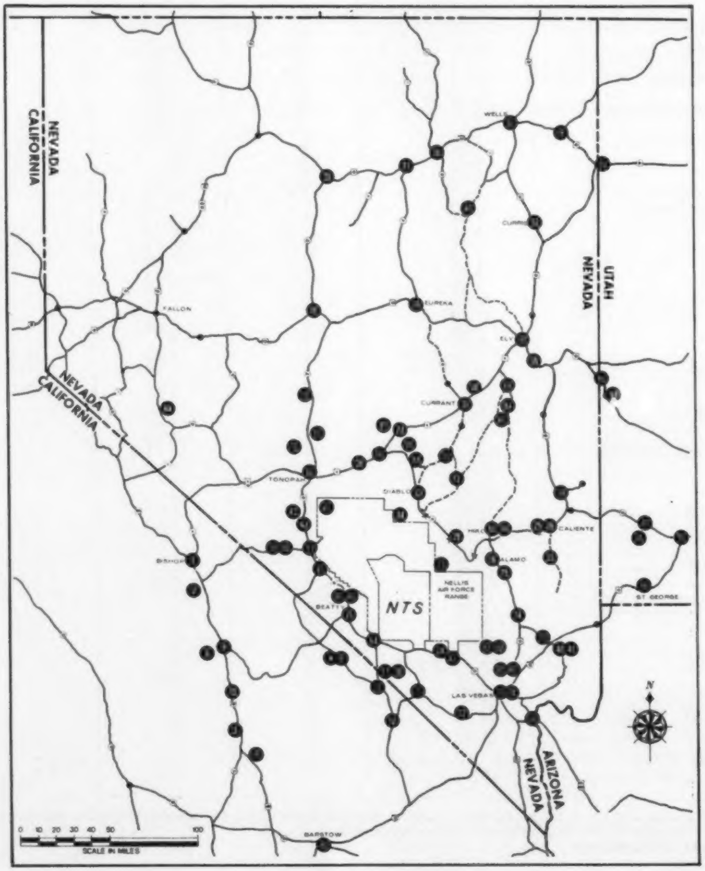

Figure 1. NERC-LV Water Surveillance Network

Table 1. Water surveillance results, July 1974

Location	Date collected (1974)	Sample type [a]	Radionuclide concentrations [b] (pCi/liter)		
			Gross alpha	Gross beta	Tritium
California:					
Bishop:					
Fish and Game Office	7/2	23	<1.7	<2.9	NA
Death Valley Junction:					
Lila's Cafe	7/3	23	<6.2	9.0±3.5	<220
Furnace Creek:					
Pond	7/3	21	<3.6	9.3±3.5	NA
Visitors Center	7/3	27	<5.1	16 ±3.9	NA
Hinkley:					
Bill Nelson Dairy	7/2	23	7.3± 5.8	3.9±3.1	NA
Lone Pine:					
Forest Service Ranger Station	7/2	24	3.0± 2.6	3.6±3.0	NA
Olancha:					
Haiwee Reservoir	7/2	21	4.1± 3.3	3.8±3.0	NA
Ridgecrest:					
City Hall	7/2	23	<4.3	5.2±3.2	NA
Nevada:					
Adaven:					
Canfield Ranch	7/9	22	20 ± 8.4	25 ±4.4	NA
Alamo:					
Pahranagat Lake	7/8	21	<3.5	3.0±3.0	NA
Sheri's Bar	7/8	23	<3.1	3.1±3.0	NA
Williams Dairy	7/10	23	<4.4	13 ±3.7	NA
Austin:					
Nevada National Bank	7/16	27	<2.5	<3.1	NA
Blue Diamond:					
Post office	7/15	23	7.1±4.8	<3.0	<230
Blue Jay Highway:					
Maintenance Station	7/11	23	<3.8	6.7±3.2	NA
Cactus Springs:					
Mobil Service Station	7/8	27	<2.8	<2.9	<230
Caliente:					
Agricultural Extension Station	7/8	23	7.3± 5.2	6.7±3.3	NA
Clark Station:					
Five Mile Ranch	7/11	27	<2.4	7.2±3.3	NA
Currant:					
Currant Ranch Cafe	7/11	27	12 ± 6.5	6.4±3.3	NA
Diablo:					
Highway Maintenance Station	7/10	23	<3.1	6.8±3.2	NA
Reed Ranch	7/10	21	26 ± 8.6	30 ±4.6	NA
Elgin:					
Water tower	7/11	23	11 ± 6.6	8.1±3.4	NA
Ely:					
Chevron Service Station	7/16	24	4.0± 2.8	3.1±3.1	NA
Comins Lake	7/16	21	14 ± 6.0	29 ±4.6	NA
Eureka:					
Highway Maintenance Station	7/16	24	6.8± 3.7	4.1±3.2	NA
Goldfield:					
Chevron Service Station	7/15	23	3.9± 3.7	<3.2	NA
Hiko:					
Crystal Springs	7/9	27	4.1± 3.8	6.2±3.2	NA
Schofield Dairy	7/10	23	31 ± 9.9	40 ±5.1	NA
Las Vegas:					
Craig Ranch Golf Course	7/2	23	<3.5	5.2±3.1	<210
Desert Game Range	7/8	23	4.5± 3.4	<2.9	<220
Lab I NERC	7/2	24	<4.5	6.7±3.3	640±220
Lake Mead Vegas Wash	7/2	21	<4.7	8.9±3.5	800±220
L V Water District Well 28	7/2	23	3.7± 3.5	<3.0	<210
Municipal Golf Course	7/2	23	4.6± 3.7	<3.0	<210
Tule Springs	7/8	23	5.2± 3.5	4.0±3.0	350±220
Tule Springs Pond	7/8	21	2.9± 2.7	<2.9	NA
Vegas Estates	7/2	23	8.6± 6.1	11 ±3.6	<210
Lida:					
Lida Livestock Company	7/15	27	5.3± 3.5	<3.1	NA
Pond at storage tank	7/15	21	3.9± 2.9	<3.1	NA
Lund:					
Gardner Grocery	7/17	23	6.4± 3.6	<3.1	NA
Manhattan:					
Country store	7/17	23	21 ± 6.9	4.1±3.2	NA
Mesquite:					
Hughes Bros. Dairy	7/16	23	<3.7	4.6±3.7	NA
Moapa:					
Pedersen Valley View Ranch	7/16	27	<4.3	11 ±3.8	NA
Mt. Charleston:					
Kyle Canyon Fire Station	7/8	27	7.3± 5.8	<3.1	270±220
Nyala:					
Sharp's Ranch	7/11	23	4.7± 3.2	3.1±3.0	NA
Pahrump:					
Texaco Service Station	7/9	23	6.0± 3.7	3.1±3.0	NA
Pioche:					
County Courthouse	7/8	24	<3.1	7.7±3.3	NA
Round Mountain					
Mobil Service Station	7/16	27	2.8± 2.2	<3.1	NA
Scotty's Junction:					
Holloway Ranch	7/15	23	8.7± 5.2	9.6±3.6	<260

See footnotes at end of table.

Table 1. Water surveillance results, July 1974—continued

Location	Date collected (1974)	Sample type [a]	Radionuclide concentrations [b] (pCi/liter)		
			Gross alpha	Gross beta	Tritium
Springdale:					
Pond	7/11	21	5.7± 5.3	8.7±3.4	NA
Sunnyside:					
Adam McGill Reservoir	7/17	21	8.2± 4.1	6.4±3.3	NA
Wildlife Management Headquarters	7/17	21	5.7± 3.2	6.8±3.3	NA
Tonopah:					
Jerry's Chevron Station	7/11	23	<3.2	7.1±3.2	NA
Tonopah Test Range CP-1	7/11	23	8.8± 5.4	6.5±3.2	NA
Warm Springs:					
Fallini's Pond	NS				
Service Station and Cafe	7/11	27	35 ±12	35 ±4.9	NA
Twin Springs Ranch	7/11	23	8.9± 5.5	13 ±3.7	NA
Utah:					
Cedar City:					
M. D. Baldwin residence	7/18	24	12 ± 2.6	11 ±3.6	NA
St. George:					
R. Cox Dairy	7/18	24	4.8± 3.0	<3.1	NA

[a] 21—Pond, lake, reservoir, stock tank, stock pond; 22—Stream, river, creek; 23—Well; 24—Multiple supply mixed (a water sample consisting of mixed or multiple sources of water such as well and spring); and 27—Spring.
[b] Two-sigma counting error provided when available.
NA, not analyzed.
NS, no sample.

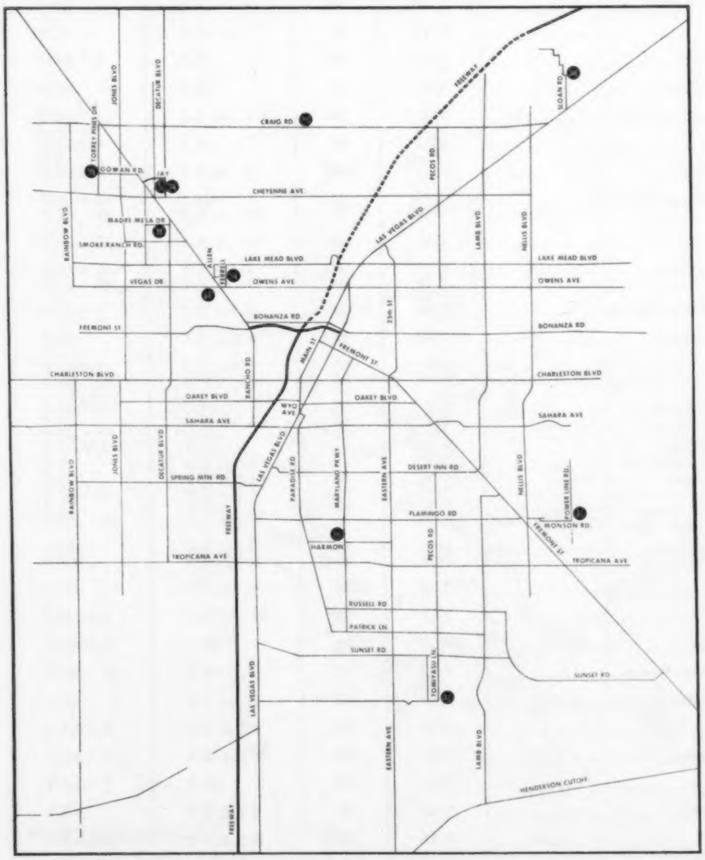

Figure 2. NERC-LV Water Surveillance Network—Las Vegas Valley

Table 2. Special analytical results for water samples collected during 1974

Location	Date collected (1974)	Sample type [a]	Radionuclide concentrations [b] (pCi/liter)							
			^{89}Sr	^{90}Sr	^{226}Ra	^{239}Pu	^{238}Pu	^{234}U	^{235}U	^{238}U
California:										
Bishop:										
Fish and Game Office	1/17	23	<3.0	<1.0	0.1 ±0.054	NA	NA	0.38±0.058	0.026±0.016	0.26 ±0.046
Death Valley Junction:										
Lila's Cafe	1/8	23	6.0±2.2	2.8± 1.4	.11 ± .060	NA	NA	6.4 ± .25	.082± .029	1.5 ± .12
Furnace Creek:										
Visitor's Center	1/8	27	<1.6	1.5 ±1.0	.23 ± .080	NA	NA	2.4 ± .14	.038± .020	.99 ± .090
Pond	1/8	21	<1.4	<.82	.16 ± .066	0.12 ±0.043	0.088±0.048	2.7 ± .15	.051± .023	1.1 ± .096
Hinkley:										
Bill Nelson Dairy	1/15	23	<3.2	<1.0	.70 ± .16	NA	NA	6.6 ± .24	.16 ± .040	5.1 ± .21
Lone Pine:										
Forest Service Ranger Station	1/16	24	<2.4	<.84	.32 ± .088	NA	NA	.36± .060	.019± .016	.27 ± .051
Olancha:										
Haiwee Reservoir	1/15	21	<3.5	<1.4	.32 ± .092	< .039	< .051	3.6 ± .17	.11 ± .030	3.1 ± .16
Ridgecrest:										
City Hall	1/15	23	<2.4	<.79	.29 ± .085	NA	NA	2.4 ± .14	.069± .026	2.0 ± .13
Nevada:										
Adaven:										
Canfield Ranch	1/16	22	<2.6	<1.1	.10 ± .059	NA	NA	2.9 ± .23	.040± .018	1.1 ± .11
Alamo:										
Williams Dairy	1/7	23	<2.4	< .90	.34 ± .094	NA	NA	3.7 ± .17	.098± .035	1.5 ± .12
Pahranagat Lake	1/7	21	<2.9	<1.1	.45 ± .10	< .038	< .068	23 ± .44	.31 ± .052	8.9 ± .28
Sheri's Bar	1/7	23	<3.0	<1.3	.18 ± .073	NA	NA	2.3 ± .14	.034± .018	.60 ± .072
Austin:										
Nevada National Bank	1/9	27	<5.5	<.77	.28 ± .086	NA	NA	16 ± .36	.54 ± .066	15 ± .35
Blue Diamond:										
Post Office	1/11	23	<1.3	<.78	.49 ± .11	NA	NA	1.5 ± .11	.022± .015	.43 ± .059
Blue Jay Highway Maintenance Station	1/17	23	<3.6	<1.1	.11 ± .060	NA	NA	3.1 ± .16	.055± .022	1.3 ± .10
Cactus Springs:										
Mobil Service Station	1/9	27	<2.2	<1.2	.12 ± .058	NA	NA	1.6 ± .12	.015± .013	.53 ± .068
Caliente:										
Agricultural Extension Station	1/10	23	<2.4	<.92	.11 ± .060	NA	NA	6.4 ± .23	.047± .022	1.5 ± .11
Clark Station:										
Five Mile Ranch	1/17	27	<2.4	<1.1	.12 ± .063	NA	NA	.70± .078	<.0089	.24 ± .046
Currant:										
Currant Ranch Cafe	1/16	27	<3.1	<.97	.089± .052	NA	NA	3.8 ± .61	.13 ± .036	3.1 ± .25
Diablo:										
Highway Maintenance Station	1/9	23	<3.7	<1.1	.11 ± .060	NA	NA	1.6 ± .12	.030± .026	.73 ± .085
Reed Ranch	1/7	21	<2.6	<1.0	.089± .057	<.031	<.064	22 ± .44	.14 ± .037	2.9 ± .16
Elgin:										
Water Tower	1/11	23	<3.0	<1.2	.10 ± .054	NA	NA	7.7 ±0.25	.094± .029	2.5± 0.14
Ely:										
Chevron Service Station	1/15	24	<2.2	<1.0	.63 ± .12	NA	NA	2.5 ± .22	.022± .018	.55 ± .080
Eureka:										
Highway Maintenance Station	1/15	24	<2.7	<.91	.13 ± .082	NA	NA	3.2 ± .26	.089± .035	1.1 ± .12
Goldfield:										
Chevron Service Station	1/8	23	<3.2	<1.1	.29 ± .086	NA	NA	2.2 ± .14	.036± .027	.56 ± .076
Hiko:										
Crystal Springs	1/10	27	<2.5	<.98	.67 ± .13	< .048	<.066	3.7 ± .18	.062± .038	1.2 ± .11
Schofield Dairy	1/7	23	<2.3	<.86	.29 ± .085	NA	NA	19 ±1.2	.26 ± .047	7.3 ± .49
Las Vegas:										
Desert Game Range	1/9	23	<1.7	<.99	.22 ± .075	NA	NA	6.4 ± .23	.082± .033	1.2 ± .10
Lab I NERC	1/14	24	<2.1	<.96	.094± .058	NA	NA	< .018	<.012	.021± .017
Lake Mead Vegas Wash	1/14	21	4.6±2.1	2.1 ±1.4	.23 ± .079	.048±0.046	<.085	2.9 ± .15	.070± .025	1.7 ± .12
Tule Springs	1/7	23	<1.6	<.96	.14 ± .059	NA	NA	2.8 ± .16	.039± .024	.76 ± .084
Tule Springs Pond	1/17	21	<3.0	<.99	.32 ± .092	<0.042	<.067	5.3 ± .21	.056± .037	1.6 ± .12
Craig Ranch Golf Course	1/14	23	<2.3	1.3 ±1.1	.34 ± .092	NA	NA	1.8 ± .12	.021± .015	.65 ± .075
Las Vegas:										
Municipal Golf Course	1/14	23	<2.6	3.9 ±1.3	.13 ± .064	NA	NA	2.1 ± .13	.034±0.019	.60 ± .071
Vegas Estates	1/14	23	<2.4	6.5 ±1.6	.23 ± .071	NA	NA	2.9 ± .15	.048± .021	.71 ± .076
L V Water District Well 28	1/14	23	<2.0	<.91	.32 ± .085	NA	NA	1.8 ± .13	.042± .024	.52 ± .070
Lida:										
Lida Livestock Company	1/7	27	<2.5	<.97	.21 ± .077	NA	NA	2.0 ± .13	<.031	.48 ± .074
Pond at storage tank	1/7	21	<3.5	<1.3	.31 ±9.088	< .085	< .066	2.6 ± .15	.029± .016	.75 ± .080

See footnotes at end of table.

Table 2. Special analytical results for water samples collected during 1974—continued

Location	Date collected (1974)	Sample type [a]	Radionuclide concentrations [b] (pCi/liter)							
			^{89}Sr	^{90}Sr	^{226}Ra	^{238}Pu	^{239}Pu	^{234}U	^{235}U	^{238}U
Lund:										
Gardner Grocery	1/16	23	<2.7	<1.2	0.24 ±0.078	NA	NA	3.2 ±0.28	0.042±0.022	1.4 ±0.15
Manhattan:										
Country Store	1/10	23	<4.0	<1.2	.22 ± .072	NA	NA	11 ± .31	.16 ± .038	4.5 ± .19
Mesquite										
Hughes Bros. Dairy	1/15	23	<3.0	<1.0	.15 ± .060	NA	NA	3.7 ± .29	.067± .032	2.2 ± .19
Moapa:										
Pedersen Valley View Ranch	1/15	27	<3.2	<1.1	1.2 ± .16	NA	NA	4.4 ± .33	.060± .023	1.3± .13
Mt. Charleston:										
Kyle Canyon Fire Station	1/7	27	<1.7	1.1 ±1.0	.30 ± .089	NA	NA	0.58± .072	.036± .020	.39 ± .057
Nyala:										
Sharp's Ranch	1/8	23	<4.2	<1.5	.14 ± .066	NA	NA	1.7 ± .12	.044± .020	.67 ± .076
Pahrump:										
Texaco Service Station	1/11	23	<1.4	<0.89	.19 ± .070	NA	NA	1.9 ±0.14	.042±0.022	0.48 ±0.068
Pioche:										
County Courthouse	1/10	24	<2.8	<1.1	.14 ± .066	NA	NA	2.0 ± .16	<.010	.50 ± .063
Round Mountain:										
Mobil Service Station	1/9	27	<3.0	<1.2	.14 ± .066	NA	NA	1.1 ± .10	.035± .020	1.1 ± .10
Scotty's Junction:										
Holloway Ranch	1/14	23	<3.0	<1.0	.11 ± .057	NA	NA	4.7 ± .35	.073±0.026	1.6 ±0.15
Springdale:										
Pond	1/8	21	<2.6	<1.1	.11 ± .060	<0.062	<0.083	6.3 ± .24	.082± .029	1.2 ± .11
Sunnyside:										
Wildlife Management Headquarters	1/16	27	<3.1	1.5± 1.3	.13 ± .056	NA	NA	2.2 ± .19	.016± .014	0.50 ± .071
Adam McGill Reservoir	1/16	21	<2.4	1.5 ±1.1	1.4 ± .20	<0.041	<0.083	2.6 ± .15	.022± .019	0.74 ± .082
Tonopah:										
Jerry's Chevron Station	1/8	23	<3.3	.96	.19 ± .067	NA	NA	3.5 ± .17	.060± .031	1.2 ± .10
Tonopah Test Range CP-1	1/8	23	<3.6	<1.1	.14 ± .067	NA	NA	.092± .047	<.023	0.054± .035
Warm Springs:										
Service Station and Cafe	1/17	27	<2.3	<.98	16 ± .60	NA	NA	.55± .073	<.012	0.15 ± .038
Twin Springs Ranch	1/10	23	<3.3	<1.0	.17 ± .064	NA	NA	5.0 ± .35	.11 ± .031	2.1 ± .17
Utah										
Cedar City:										
M. D. Baldwin Residence	1/16	24	<3.2	<1.1	.44 ± .11	NA	NA	.33± .058	<. 016	.14 ± .037
St. Georges:										
R. Cox Dairy	1/17	24	<3.0	<1.0	.13 ± 0.65	NA	NA	1.7 ±0.13	.039±0.022	.98 ± .094

[a] 21—Pond, lake, reservoir, stock tank, stock pond.
22—Stream, river, creek.
23—Well.
24—Multiple supply mixed (a water sample consisting of mixed or multiple sources of water such as well and spring).
27—Spring.

[b] Two-sigma counting error provided when available.
NA, not analyzed.
NS, no sample.

quested. A complete description of sampling and analytical procedures was included with the water results reported in the July 1973 issue of *Radiation Data and Reports.*

Results

The routine analytical results of all water samples collected in the third quarter of 1974 by the NERC-LV are listed in table 1. No gamma-emitting fission products were identified by gamma spectrometry in any of the third quarter samples. Table 2 shows the results for water samples selected for special analyses during 1974.

SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta radioanalysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Environmental Protection Agency, the Canadian Department of National Health and Welfare, and the Pan American Health Organization.

In addition to those programs presented in this issue, the following programs were covered previously in *Radiation Data and Reports.*

Network	Period	Issue
ERAMS krypton-85 in air component	January–June 1973	November 1974
ERAMS plutonium and uranium in air component	January–March 1974	November 1974
Fallout in the United States and other areas	1972	August 1974
Mexican air monitoring program	January–June 1974	November 1974

1. ERAMS Gross Radioactivity and Deposition Component, July 1974

Office of Radiation Programs
Environmental Protection Agency

The Environmental Radiation Ambient Monitoring System (ERAMS), which began in July 1973, was developed from previously operating radiation monitoring networks to form a single monitoring system which is more responsive to current and projected sources of environmental radiation.

The ERAMS Gross Radioactivity and Deposition Component is a restructuring of the previous Radiation Alert Network (RAN). Sampling stations were relocated to more closely monitor the potential sources of environmental radioactivity and to provide the means for obtaining the maximum population coverage (figure 1). The component consists of 74 sampling stations, 54 of which are on standby status and can be activated when the need arises (figure 1). The remaining 20 stations collect air particulates continuously with the filters being changed one or two times per week. Most of the stations are operated by State or local health department personnel.

The station operators perform gross beta radioactivity "field estimates" on the airborne particulate samples at 5 hours after collection, when most of the radon daughter products have decayed, and at 29 hours after collection, when most of the thoron daughter products have decayed. The airborne particulate samples and precipitation samples, which are collected concurrently at the 20 air sampling stations, are sent to the Eastern Environmental Radiation Facility for laboratory gross beta radioactivity analyses. All field estimate results are reported to the appropriate Environmental Protection Agency officials by mail or telephone depending on the levels found. A compilation

Figure 1. ERAMS Gross Radioactivity and Deposition Component sampling locations

Table 1. Gross beta radioactivity in surface air and precipitation, July 1974

Station location		Number of samples	Gross beta radioactivity (pCi/m³): 5-hour field estimate: Maximum	Minimum	Average [a]	Laboratory measurement: Maximum	Minimum	Average [a]	Precipitation: Laboratory estimate of deposition: Depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	18	3	1	2	0.19	0.06	0.11	54	0.34
	Muscle Shoals	0								
Alaska:	Anchorage	7	0	0	0	.15	.03	.08		
	Attu Island	5				<.01	<.01	<.01		
	Fairbanks	7				.09	.05	.06		
	Juneau	0								
	Nome	0								
	Point Barrow	0								
Ariz:	Phoenix	0								
Ark:	Little Rock	4	1	0	1	.22	.08	.16		
Calif:	Berkeley	10	0	0	0	.30	.02	.07	9	.04
	Los Angeles	14	2	0	1	.14	.03	.09		
C.Z:	Ancon	3	0	0	0	.09	.01	.04		
Colo:	Denver	13	4	1	2	.32	.05	.17	38	.78
Conn:	Hartford	5	1	0	1	.21	.07	.13	40	1.79
	Wilmington	4	1	0	1	.26	.08	.19		
D.C:	Washington	5	0	0	0	.31	.07	.21		
Fla:	Jacksonville [b]	23	1	0	0	.28	.03	.12		
	Miami	21	3	0	0	.14	.03	.07	104	1.27
Ga:	Atlanta	6				.29	.08	.18		
Guam:	Agana	0								
Hawaii:	Honolulu	4	0	0	0	.12	.08	.09		
Idaho:	Boise	4	1	1	1	.19	.13	.16		
	Idaho Falls	8				.27	.08	.16		
Ill:	Chicago	3	2	0	1	.20	.17	.18		
Ind:	Indianapolis	5	0	0	0	.26	.11	.17		
Iowa:	Iowa City	5	3	1	2	.24	.14	.18		
Kans:	Topeka	3	3	1	2	.22	.07	.15		
Ky:	Frankfort	2	1	1	1	.20	.13	.17		
La:	New Orleans	3	0	0	0	.20	.10	.15		
Maine:	Augusta	22	1	0	0	.17	.02	.11	52	1.63
Md:	Baltimore	3	1	0	1	.28	.09	.20	10	.43
Mass:	Lawrence	0								
Mich:	Grand Rapids	0								
	Lansing [c]	22	3	0	1	.22	.04	.13	30	1.52
Minn:	Minneapolis	7	3	1	2	.31	.10	.22		
Miss:	Jackson	10	1	0	1	.21	.09	.14		
Mo:	Jefferson City	5	2	1	1	.24	.12	.18	17	.92
Mont:	Helena	5	2	1	1	.19	.10	.15		
Nebr:	Lincoln	4	4	1	3	.17	.12	.14		
Nev:	Las Vegas	12	3	1	1	.28	.05	.14	8	.04
N.H:	Concord	0								
N.J:	Trenton	22	2	0	1	.30	.07	.17	81	5.7
N. Mex:	Santa Fe	7	2	0	1	.55	.05	.15		
N.Y:	Albany	4	1	0	1	.17	.09	.14		
	Buffalo	9	1	0	1	.23	.12	.17	6	.01
	New York City	0								
	Syracuse	3				.18	.16	.17		
N.C:	Charlotte	0								
	Wilmington	0								
N. Dak:	Bismarck	10	5	0	1	.23	.09	.13	40	.76
Ohio:	Cincinnati	0								
	Columbus [d]	15	4	1	2	.59	.10	.21		
	Painesville	0								
Okla:	Oklahoma City	0								
Oreg:	Portland	9	0	0	0	.10	.03	.06	41	.22
Pa:	Harrisburg	21	2	0	1	.27	.08	.14	7	.33
	Pittsburgh	0								
P.R:	San Juan	4				.11	.07	.09		
R.I:	Providence	13	1	0	1	.23	.08	.13		
S.C:	Anderson	0								
	Columbia	14	2	0	1	.23	.05	.12	150	1.68
S. Dak:	Pierre	9				.23	.11	.17		
Tenn:	Chattanooga	0								
	Nashville [e]	15	3	1	1	.34	.09	.18	22	.34
Tex:	Austin	4	3	2	2	.24	.07	.10		
	El Paso	7	3	0	1	.14	.04	.09		
Utah:	Salt Lake City	0								
Va:	Lynchburg	11	2	0	1	.30	.04	.12		
	Norfolk	4	1	0	0	.24	.02	.14		
Wash:	Seattle	6	0	0	0	.06	.02	.05		
	Spokane	8	2	1	1	.12	.04	.09		
Wisc:	Madison	8	2	0	1	.24	.09	.15	11	.46
Wyo:	Cheyenne	5	6	2	3	.25	.14	.21		
Network summary		480	6	0	1	0.59	<0.01	0.14	40	1.01

[a] The monthly average is calculated by weighting the estimates of individual air samples with length of sampling period.
[b] Station to be relocated in Tampa.
[c] Station to be relocated in Detroit.
[d] Station to be relocated in Toledo.
[e] Station to be relocated in Knoxville.

of the daily measurements is available upon request from the Eastern Environmental Radiation Facility, Montgomery, Ala. 36109.

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate and laboratory techniques during July 1974. The standby stations were activated following the June 17, 1974, detonation of an atmospheric nuclear test by the Peoples Republic of China, and were operational through most of July 1974.

2. Air Surveillance Network, July 1974

National Environmental Research Center—
Las Vegas
Environmental Protection Agency

The Air Surveillance Network,[1] operated by the National Environmental Research Center—Las Vegas (NERC-LV), consists of 49 active and 72 standby sampling stations located in 21 western States (figures 2 and 3). The network is operated in support of nuclear testing sponsored by the U.S. Atomic Energy Commission (AEC) at the Nevada Test Site (NTS), and at any other designated testing sites.

The stations are operated by State health department personnel and by private individuals on a contract basis. All active stations are operated continuously with filters being exchanged after periods generally ranging from 48 to 72 hours. All standby stations except six stations near the NTS, were activated from June 19 to mid-July for the purpose of checking the operability of the stations and collecting radioactive fallout from a nuclear detonation conducted by the People's Republic of China on June 16, 1974. All samples were mailed to the NERC-LV. A complete description of sampling and analytical procedures was presented in the February 1972 issue of *Radiation Data and Reports*.

Table 2 presents the average gross beta concentrations in air for each of the network stations. The minimum reporting concentration for gross beta activity is 0.1 pCi/m^3. For reporting purposes, concentrations less than 1.0 pCi/m^3 are reported to one significant figure, and those equal to or greater than 1.0 pCi/m^3 are reported to two significant figures. For averaging purposes, individual concentration values less than the minimum detectable concentration (MDC) ($\sim$0.03 pCi/m^3 for a 700 m^3 sample) are set equal to the MDC. Reporting and rounding-off conventions are as follows:

[1] This network is operated under a Memorandum of Understanding (No. AT(26-1)-539) with the Nevada Operations Office, U.S. Atomic Energy Commission.

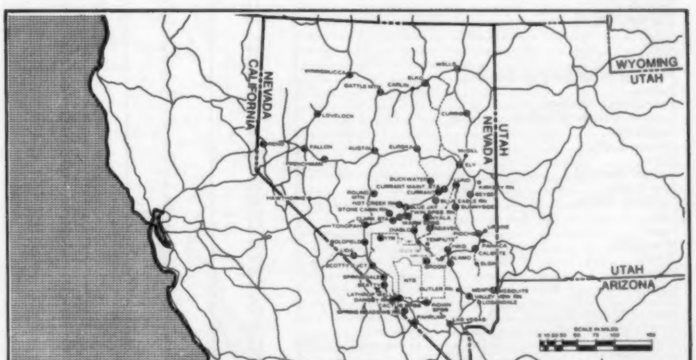

Figure 2. NERC-LV Air Surveillance Network stations in Nevada

Concentration (pCi/m³)	Reported value of concentration above MDC (pCi/m³)	Reported value of concentration below MDC (pCi/m³)
<0.05	<0.1	<0.1
≧0.05 <0.15	0.1	<0.1
≧0.15	As calculated and rounded	Calculated MDC

Table 2. Summary of gross beta radioactivity concentrations in air, July 1974

Location		Number of samples	Concentration (pCi/m³)		
			Maximum	Minimum	Average
Ariz:	Kingman	14	.8	<.1	.3
	Phoenix	6	.3	.2	.2
	Seligman	14	.9	.1	.3
	Winslow	5	.7	.2	.4
Ark:	Little Rock	4	.2	.1	.2
Calif:	Baker	27	.6	<.1	.3
	Barstow	23	.7	<.1	.2
	Bishop	14	.9	.1	.4
	Death Valley Junction	14	.7	.1	.3
	Furnace Creek	14	.7	<.1	.3
	Indio	5	.5	.1	.3
	Lone Pine	14	.6	.1	.3
	Needles	4	.5	.2	.4
	Ridgecrest	14	.4	.1	.2
	Shoshone	14	.4	.1	.2
Colo:	Denver	5	1.0	.4	.6
	Durango	1	.2	.2	.2
Idaho:	Boise	6	.3	.2	.2
	Idaho Falls	6	.5	.3	.4
	Preston	2	.5	.4	.4
	Twin Falls	5	.3	.2	.3
Iowa:	Iowa City	5	.3	<.1	.2
	Sioux City	6	.5	.1	.3
Kans:	Dodge City	3	.2	.1	.2
La:	Lake Charles	5	.2	.1	.1
	Monroe	5	.3	<.1	.1
	New Orleans	2	.3	.1	.2
Mo:	Clayton	5	.4	.2	.2
	Joplin	5	.5	.1	.2
	St. Joseph	5	.4	.2	.2
Nebr:	North Platte	5	.6	<.1	.2
Nev:	Alamo	13	.7	.1	.3
	Austin	13	.5	.1	.2
	Battle Mountain	5	.5	.1	.3
	Beatty	14	.8	<.1	.2
	Blue Eagle Ranch (Currant)	14	.4	<.1	.2
	Blue Jay	14	.5	<.1	.2
	Caliente	13	.5	<.1	.2
	Currant Ranch	12	.6	.1	.3
	Currie	3	.3	.2	.2
	Diablo	14	.7	.1	.3
	Duckwater	12	.7	<.1	.3
	Elko	5	.6	.2	.4
	Ely	13	.6	<.1	.2
	Eureka	14	.6	.1	.3
	Fallini's Twin Springs Ranch	14	.6	<.1	.3
	Fallon	4	.5	.1	.4
	Frenchman Station	4	.5	.2	.4
	Geyser Ranch (Pioche)	6	.7	<.1	.2
	Goldfield	14	.6	<.1	.2
	Groom Lake	10	.4	.1	.2
	Hiko	14	.7	.1	.3
	Indian Springs	14	.5	.1	.2
	Las Vegas	21	.7	.1	.3
	Lathrop Wells	15	.4	.1	.2
	Lida	11	.2	<.1	.1
	Lund	14	.7	<.1	.2
	Mesquite	14	.5	.1	.2
	Nyala	14	.8	<.1	.3
	Pahrump	14	.9	.1	.3
	Pioche	14	.5	.1	.2
	Reno	5	.4	.1	.3
	Round Mountain	14	.8	.1	.3
	Scotty's Junction	13	.6	.1	.3
	Stone Cabin Ranch	14	.2	<.1	.1
	Sunnyside	12	.6	.1	.2
	Tonopah	14	1.4	.1	.4
	Tonopah Test Range	14	.7	.1	.2

Table 2. Summary of gross beta radioactivity concentrations in air, July 1974—continued

Location		Number of samples	Concentration (pCi/m³) Maximum	Minimum	Average
Nev:	Warm Springs	6	0.4	<0.1	0.2
	Warm Springs Ranch	8	.1	<.1	.1
	Wells	5	.6	.3	.4
	Winnemucca	5	.5	.2	.3
N. Mex:	Albuquerque	5	.8	<.1	.3
	Carlsbad	5	.3	.1	.1
Okla:	Muskogee	5	.3	.1	.2
Oreg:	Burns	5	.4	.2	.3
	Medford	2	.2	.1	.2
S. Dak:	Aberdeen	4	.4	.1	.2
	Rapid City	5	.4	.2	.3
Tex:	Abilene	5	.2	.1	.1
	Austin	9	.2	.1	.1
	Fort Worth	5	.2	.1	.1
Utah:	Bryce Canyon	10	.7	.2	.4
	Cedar City	5	.2	.1	.1
	Delta	14	.4	<.1	.2
	Dugway	5	.7	.2	.5
	Enterprise	5	.6	.3	.4
	Garrison	14	.6	.1	.3
	Logan	4	.5	.3	.4
	Milford	13	.7	<.1	.2
	Monticello	5	.3	<.1	.2
	Parowan	5	.8	.2	.4
	Provo	4	.6	.2	.4
	Salt Lake City	5	.4	.2	.4
	St. George	13	.4	.1	.2
	Wendover	4	.7	.3	.4
Wash:	Seattle	5	.1	<.1	.1
	Spokane	5	.2	<.1	.1
Wyo:	Rock Spring	4	.8	.2	.5
	Worland	5	.5	.4	.4

As shown by table 2, the highest gross beta concentrations within the network was 1.4 pCi/m³ at Tonopah, Nev., during July 19–22 1974.

From gamma spectrometry results, fission products in varying combinations of zirconium-95, ruthenium-106, and cerium-144 were identified on filters collected throughout the network. Trace amounts of uranium-237 were also

Figure 3. NERC-LV Air Surveillance Network stations outside Nevada

detected, but were insufficient for quantitation. The highest concentrations of these radionuclides, respectively, were as follows:

Radionuclide	Maximum concentration (pCi/m³)	Station	Collection period
Zirconium-95	0.93	Fallini's Ranch, Nev.	June 28-July 1
Ruthenium-106	.95	Pahrump, Nev.	July 5-8
Cerium-144	.44	Las Vegas, Nev.	July 2-3
Barium-140	.47	Fallini's Ranch, Nev.	July 5-8

These radionuclides are attributed to seasonal variations in worldwide fallout and a nuclear detonation by the People's Republic of China. No radionuclides were identified by gamma spectrometry on any charcoal cartridges during July 1974.

Complete copies of this summary and listings of the daily gross beta and gamma spectrometry results are distributed to EPA Regional Offices and appropriate State agencies. Additional copies of the daily results may be obtained from the NERC-LV upon written request.

3. Canadian Air and Precipitation Monitoring Program,[3] July 1974

Radiation Protection Bureau
Department of National Health and Welfare

The Radiation Protection Bureau of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 4), where the sampling equipment is operated by personnel from the Atmospheric Environment Service of the Department of the Environment. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*1–5*).

[3] Prepared from information and data obtained from the Canadian Department of National Health and Welfare, Ottawa, Canada.

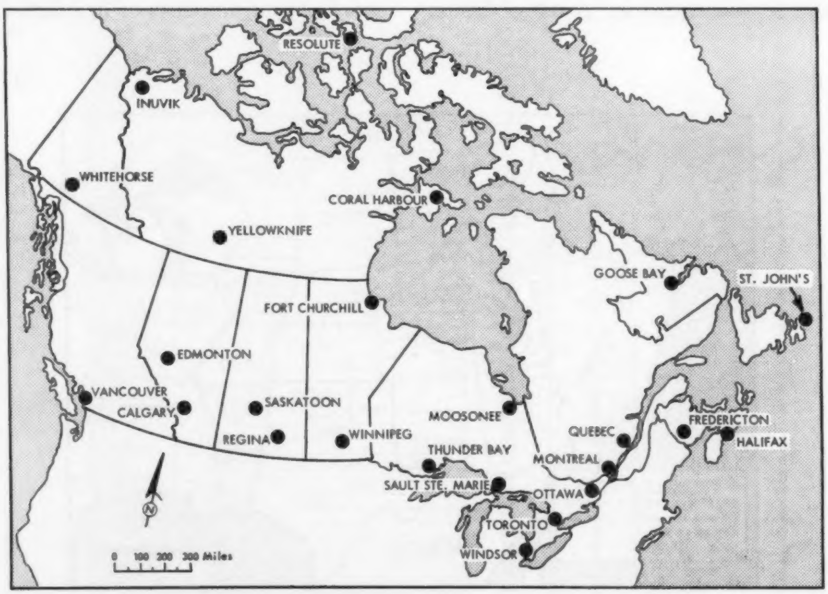

Figure 4. Canadian air and precipitation sampling stations

Table 3. Canadian gross beta radioactivity in surface air and precipitation, July 1974

Location	Number of samples	Air surveillance gross beta radioactivity (pCi/m^3)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentration (pCi/liter)	Total deposition (nCi/m^2)
Calgary	20	0.33	0.05	0.19	89.0	3.4
Coral Harbour	23	.17	.01	.09	NS	NS
Edmonton	20	.21	.02	.12	47.1	6.1
Ft. Churchill	20	.18	< .01	.09	86.6	2.5
Fredericton	17	.22	.02	.12	82.8	4.4
Goose Bay	20	.20	< .01	.10	57.1	3.5
Halifax	21	.28	.02	.15	51.5	5.0
Inuvik	19	.23	.01	.12	43.4	3.6
Montreal	20	.32	.02	.17	51.0	7.4
Moosonee	20	.24	.01	.13	38.3	5.3
Ottawa	11	.18	.01	.10	50.1	3.9
Quebec	22	.46	< .01	.23	11.1	2.1
Regina	18	.50	.04	.27	89.6	3.5
Resolute	5	.24	.02	.13	87.2	3.1
St. John's, Nfld	17	.29	.01	.15	23.2	2.1
Saskatoon	20	.23	< .01	.12	91.2	5.3
Sault Ste. Marie	20	.26	.01	.14	79.1	2.6
Thunder Bay	31	.46	.04	.25	74.9	3.5
Toronto	NS				129.8	3.1
Vancouver	18	.63	.01	.32	79.6	6.0
Whitehorse	20	.25	.01	.13	66.3	3.3
Windsor	NS				49.9	3.6
Winnipeg	20	4.76	< .01	2.38	77.4	2.5
Yellowknife	12	.22	.03	.03	60.8	2.8
Network summary	414	4.76	<0.01	0.25	66.0	3.9

NS, no sample.

A summary of the sampling procedures and methods of analysis was presented in the May 1969 issue of *Radiological Health Data and Reports*.

Surface air and precipitation data for July 1974 are presented in table 3.

REFERENCES

(*1*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report of 1959 on the Radioactive Fallout Study Program, CNHW-RP-3. Department of National Health and Welfare, Ottawa, Canada (May 1960).

(*2*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report for 1960 on the Radioactive Fallout Study Program, CNHW-RP-4. Department of National Health and Welfare, Ottawa, Canada (December 1961).

(*3*) MAR, P. G. Annual report for 1961 on the Radioactive Fallout Study Program, CNHW-RP-5. Department of National Health and Welfare, Ottawa, Canada (December 1962).

(*4*) BEALE, J. and J. GORDON. The operation of the Radiation Protection Division Air Monitoring Program, RPD-11. Department of National Health and Welfare, Ottawa, Canada (July 1962).

(*5*) BOOTH, A. H. The calculation of permissible levels of fallout in air and water and their use in assessing the significance of 1961 levels in Canada, RPD-21. Department of National Health and Welfare, Ottawa, Canada (August 1962).

4. Pan American Air Sampling Program July 1974

Pan American Health Organization and U.S. Environmental Protection Agency

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the Environmental Protection Agency (EPA) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 5. Analytical techniques were described in the March 1968 issue of *Radiological Health Data and Reports*. The July 1974 air monitoring results from the participating countries are given in table 4.

Figure 5. Pan American Air Sampling Program stations

Table 4. Summary of gross beta radioactivity in Pan American surface air, July 1974

Station location		Number of samples	Gross beta radioactivity (pCi/m^3)		
			Maximum	Minimum	Average[a]
Argentina:	Buenos Aires	0			
Bolivia:	La Paz	0			
Chile:	Santiago	30	4.06	0.00	0.53
Colombia:	Bogota	23	.43	.00	.09
Ecuador:	Cuenca	18	12.42	.01	2.15
	Guayaquil	30	2.95	.01	.53
	Quito	8	9.78	.00	1.33
Guyana:	Georgetown	1	.01	.01	.01
Jamaica:	Kingston	0			
Peru:	Lima	5	.19	.06	.13
Trinidad and Tobago:	Port of Spain	0			
Venezuela:	Caracas	2	.06	.03	.05
Pan American summary		117	12.42	0.00	0.72

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values less than 0.005 pCi/m^3 are reported and used in averaging as 0.00 pCi/m^3.

5. California Air Sampling Program July 1974

Radiologic Health Section
California Department of Health

The Radiologic Health Section of the California Department of Health with the assistance of several cooperating agencies and organizations operates a surveillance system for determining radioactivity in airborne particulates. The air sampling locations are shown in figure 6.

One of the objectives of the program is to evaluate the possibility that fixed effluent

Figure 6. California air sampling program stations

sources contribute to particulate activity in the air. Consequently, data from continuous air samplers placed in proximity to nuclear facilities are compared with those from similar equipment in nearby communities and at several "background" stations.

Airborne particles are collected by a continuous sampling of air filtered through a 47 millimeter membrane filter, 0.8 micron pore size, using a Gast air pump of about 2-cubic feet per minute capacity, or 81.5 cubic meters per day. Air volumes are measured with a direct reading gas meter. Filters are replaced every 24 hours except on holidays and weekends.

All air samples are sent to the Sanitation and Radiation Laboratory of the State Department of Health. The filters are analyzed for gross alpha and beta radioactivity, 72-hours after the end of the collection period. The daily samples then are composited into a monthly sample for gamma spectroscopy and an analysis for strontium-89 and strontium-90. Table 5 presents the gross beta radioactivity in air for July 1974.

Table 5. Gross beta radioactivity in California air, July 1974

Station location	Number of samples	Gross beta radioactivity (pCi/m^3)		
		Maximum	Minimum	Average
Bakersfield	22	0.61	0.15	0.35
Barstow	28	.85	.10	.34
Berkeley	31	.45	.00	.11
Diablo Canyon Nuclear Power Plant	8	.15	.05	.11
El Centro	21	1.93	.05	.30
Eureka	21	.36	.01	.12
Fresno	16	.50	.18	.29
Humboldt Bay Nuclear Power Plant	14	.20	.00	.09
Livermore	21	.32	.00	.18
Los Angeles	21	.41	.08	.18
Rancho Seco Nuclear Power Plant	14	.44	.09	.26
Redding	12	1.06	.19	.59
Sacramento	22	.30	.06	.17
Salinas	22	.48	.04	.13
San Bernardino	20	.44	.08	.26
San Diego	23	.28	.09	.18
San Luis Obispo	22	.26	.05	.14
San Onofre Nuclear Generating Station	4	.23	.12	.17
Summary	342	1.93	0.00	0.22

SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, Alaskan surveillance and environmental monitoring around nuclear facilities.

Offsite Surveillance Around the Nevada Test Site, July-December 1970[1]

National Environmental Research Center—
Las Vegas[2] and
Nevada Operations Office, AEC

In accordance with a Memorandum of Understanding between the U.S. Atomic Energy Commission (AEC) and Environmental Protection Agency (EPA), the National Environmental Research Center, Las Vegas (NERC-LV) conducted a program of radiological monitoring and environmental sampling in the offsite area surrounding the Nevada Test Site (NTS) and the Project Rulison test well.

During the period, July through December 1970, six announced underground nuclear tests were sponsored by the U.S. Atomic Energy Commission at the NTS and natural gas production test flaring operations were conducted at the Project Rulison site. The results of surveillance performed for "Baneberry" and Project Rulison are summarized in this report.

For the NTS, the offsite area is defined as that area beyond the boundary of the NTS and adjacent restricted areas such as the Nellis Air Force Range, Tonopah Test Range, and the Nuclear Rocket Development Station. For simplicity, these combined areas will be referred to in this report as the test range complex. At Project Rulison near Grand Junction, Colo., the offsite area extended from a 180-meter radius from the experimental natural gas well.

Operational procedures

Before each event at the test range complex, mobile monitoring teams were sent to the offsite areas most likely to be affected by a release of radioactive material. When a release occurred, the teams conducted a monitoring program directed from the NTS Control Point via two-way radio communications. Environmental sampling and monitoring continued until levels of radioactivity returned to background levels.

Each monitor carried two Eberline E–500B GM survey meters, one Rank Nucleonics NE–148 scintillation instrument, and one Victoreen Radector, Model No. AGB–50B–SR, ionization chamber instrument for monitoring radiation levels. The E–500B has a range of 0 to 200 milliroentgens per hour (mR/h) for gamma or beta-gamma detection in four ranges with an external halogen-quenched Geiger-Mueller (GM) tube, and a 0 to 2000 mR/h range for gamma detection from an internal Anton 302 GM tube. The NE–148, which has a 2.5 by 4 cm sodium iodide crystal detector, is used primarily to indicate the presence of low levels of gamma radiation and has a range of 0 to 3 mR/h in three ranges. The Radector has a range of 0.05 to 50 000 mR/h over two logarithmic ranges, using an inert gas ionization chamber as the detector. These instruments were routinely calibrated to ± 20 percent with a standardized cesium-137 source. Each monitor was also equipped with portable battery-operated strip chart recorders, battery-operated air

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[1] This article is a summary of report No. NERC-LV-539-17, "Off-site Surveillance Activities of the National Environmental Research Center from July through December 1970."

[2] During the period of this report, the NERC-LV was the Southwestern Radiological Health Laboratory and the Western Environmental Research Laboratory.

samplers, and equipment for collecting milk, water, and vegetation samples. Extra thermoluminescent dosimeters were issued to residents in the downward trajectory in the event of a release of radioactivity.

For Project Rulison, monitors also carried portable battery-operated samplers equipped with molecular sieve sampling heads and battery-powered compressors for tritium and noble gas sampling. The monitors were positioned according to aerial plume-tracking information which was radioed directly from the aircraft.

Exposure rate recorders

Eberline RM–11 gamma exposure rate recorders were used to document cloud passage at fixed locations (figure 1). These recorders have a GM tube detector with a 0.01 to 100 mR/h range and are calibrated to $\pm$ 20 percent with a cesium-137 source. The gamma exposure rate is recorded on a 30-hour strip chart.

Aerial cloud tracking

For each event at the test range complex, an Air Force U-3B aircraft with two NERC-LV monitors carrying portable instruments similar to those used by ground monitors was used to track any radioactive effluents. A NERC-LV T–34 aircraft was also used for tracking for Baneberry. Two NERC-LV cloud sampling and tracking aircraft were also used to obtain in-cloud samples to assess total cloud volume, to provide long-range tracking, and to assist in positioning ground monitors.

For project Rulison gas flaring operations, aerial plume-tracking and sampling were performed with a twin-engine Turbo-Beech aircraft. Since radioactivity concentrations in the plume from the gas-flaring stack were so low that gamma and beta detectors could not be used, plume-tracking was accomplished with a condensation nuclei monitoring instrument. This instrument, which measured the airborne concentration of condensation nuclei resulting from the burning of the natural gas, was mounted in the aircraft cabin immediately behind an air baffle at the discharge end of an air sampling probe mounted in the nose of the aircraft. The instrument output was fed to a strip-chart recorded in the copilot's instrument panel, providing the crew chief with continuous information on plume trajectory, size and dispersion. This information was radioed to a ground control center so that ground monitoring personnel would be positioned to collect samples in the plume ground track.

Atmospheric moisture and noble gas samples in the plume were collected from the aircraft sampling probes with a grab sampler. Grab

Figure 1. NERC-LV Air Surveillance Network stations outside Nevada

samples were obtained by gathering air from the sampling probe in a 1-cubic-meter plastic bag over a 30-second period. The collected air was then pumped through a canister containing 1000 grams of Linde type 13X molecular sieve for water vapor and CO_2 collection, and then into a compressed air bottle. Cryogenic sampling was used to freeze out H_2O, CO_2, and noble gases. The molecular sieve material and air bottles were then returned to the NERC-LV for tritium and noble gas analysis.

Air sampling

During this 6-month period, the routine NERC-LV Air Surveillance Network consisted of 102 offsite stations operating in every State west of the Mississippi River, except Montana and North Dakota (figures 1–2). In addition, 10 standby stations were available to be activated by telephone. The air sampler used in the Air Surveillance Network is a Gelman Tempest, consisting of a Gast Model 1550 vacuum pump driven by an electric motor. The sampler has an approximate flow rate of 0.3 m^3/min and uses a 10 cm diameter glass-fiber filter. Activated charcoal cartridges were placed behind the filter at 22 offsite stations near the test range complex and could be added to the other stations when necessary to collect gaseous fission products. The total volume of air sampled was calculated from the average flow rate and the total sampling time. These samplers operate 24 hours a day. During this period, eight additional standby stations were established in Nevada. These stations were set up to be operated by NERC-LV personnel if a release of radioactivity occurred.

Continuous collection of atmospheric particulate and moisture samples during Project Rulison flarings was accomplished at seven fixed monitoring stations at populated locations in the vicinity of the test well. Metal storage sheds were set up to house the samplers. Air was drawn through a particulate filter located outside the shed and then through a canister containing 700 grams of molecular sieve for water collection. The samplers were operated for 48-hour periods at an average flow rate of 3 liters/min.

Additionally, portable battery-powered air samplers were used to collect atmospheric moisture samples at ground level. Based on aerial tracking information, monitoring personnel were positioned in the downwind plume trajectories. The monitors carried portable two-way radios to receive instructions concerning sampling times and position changes. The portable sampler consisted of an automobile-type vacuum cleaner powered by a 12-volt battery. Air flow was measured by a dry gas meter. Air was first passed through a 10-cm-diameter glass fiber filter to remove particulates, and then passed through a 300-gram molecular sieve canister to remove the moisture. A battery-

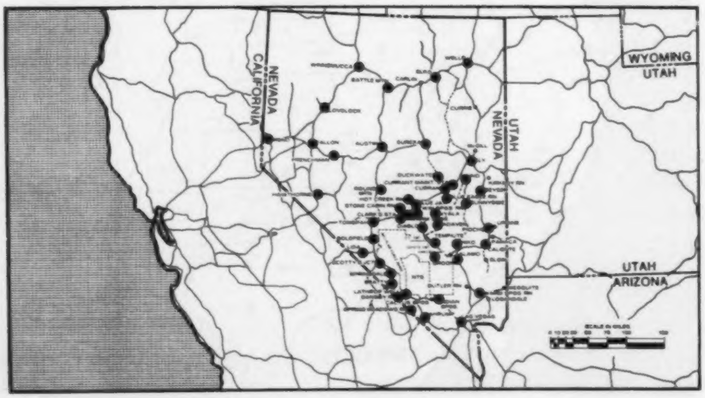

Figure 2. NERC-LV Air Surveillance Network stations in Nevada

powered compressor was also used to collect air samples for tritium and noble gas analysis. Carbon-14 analysis was performed on the CO_2 obtained from molecular sieve samples.

Milk and water sampling

Routine sampling of milk from commercial dairies, producer dairies and family cows around the test range complex continued through the 6-month period (figure 3). About 30 sources were routinely sampled, most on a monthly basis. A total of 190 samples was collected from these locations. In the event of cloud passage over a specific area, intensified sampling within the area was conducted to document changes in activity.

A standby network which could be activated by telephone and consisting of 185 milk processing plants located in the 11 western States was maintained. Each plant was supplied with containers and mailing cartons to send daily samples for 1 week to the NERC-LV for analysis. Periodically, sections of the network were

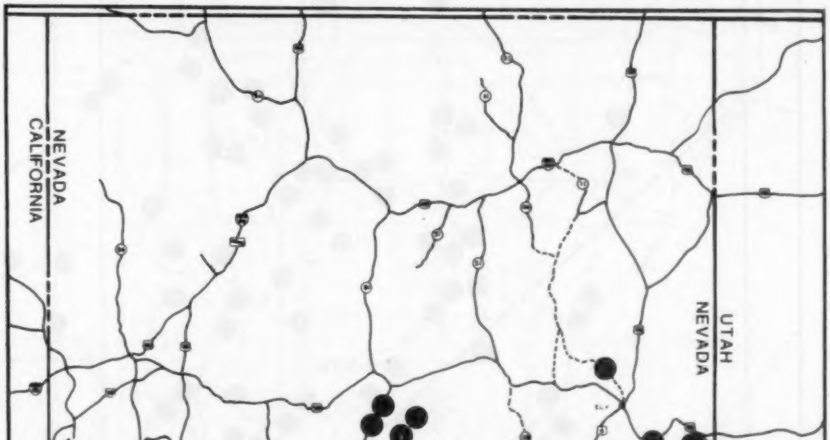

Figure 3. Routine milk sampling stations

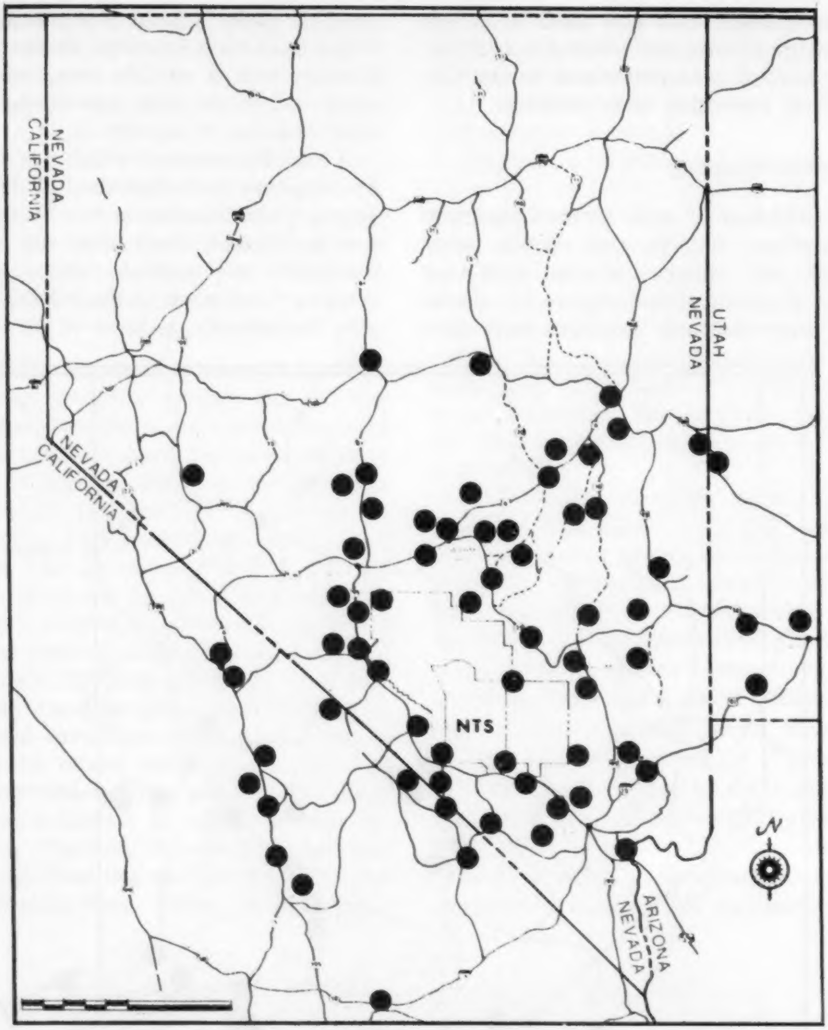

Figure 4. Routine water sampling stations

activated to test the response and reliability of the system. During this reporting period, 300 samples were collected from the network.

Domestic and nondomestic water supplies around the test range complex were sampled on a routine basis (figures 4 and 5). Water sampling was increased when a release occurred. During this period, 569 water samples were collected from about 90 sources.

A total of 62 milk and 251 water samples was collected from special sampling locations in the Rulison vicinity. Daily water samples were collected from Battlement Creek, which runs within several hundred meters of the test well, while all other water sampling stations were sampled on a monthly schedule. The sampling stations included both domestic and surface water supplies. Milk samples from family cows

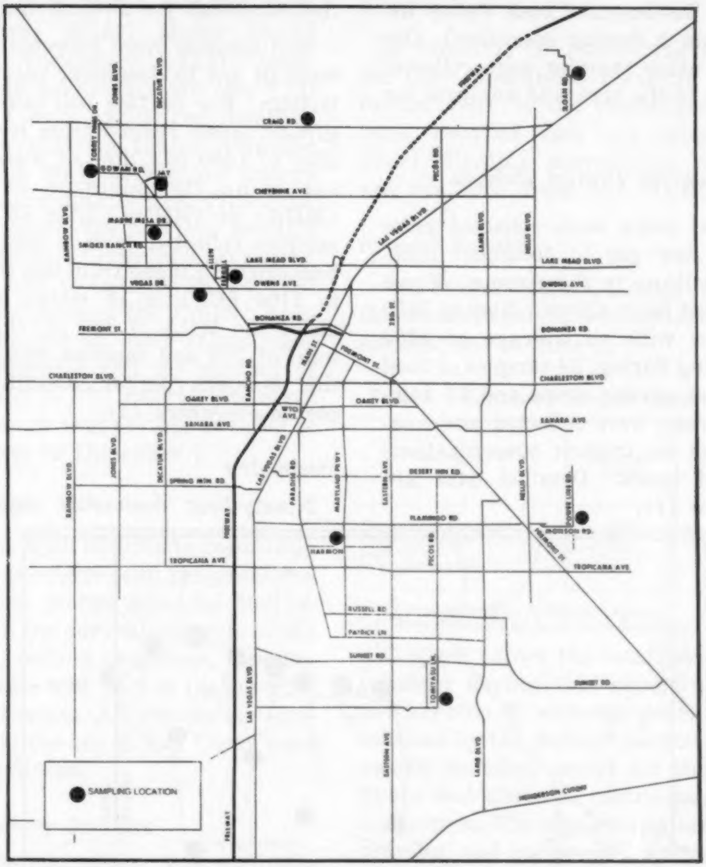

Figure 5. Las Vegas Valley routine water sampling stations

and Grade-A dairies were also collected on a monthly basis for tritium analysis.

Precipitation collectors were provided at seven fixed sampling stations, and portable precipitation collectors were set up by field personnel at other locations as conditions dictated. Snow samples were collected during the winter flaring operations.

Vegetation sampling

Normally, vegetation samples around the test range complex were collected only in the event of a release of radioactive material and analyzed for gross gamma radioactivity to delineate the fallout pattern. At most locations where milk samples were collected, samples of cow feed were collected and analyzed for specific radionuclides. For Project Rulison, 95 natural vegetation samples were collected within a 32-km radius of the site. All samples were analyzed for tritium.

Special sampling for Project Rulison

Periodic samples of animal tissue from both wildlife and domestic animals were collected through the assistance of local slaughter houses and the Colorado Fish, Game and Parks Department. Several blood samples were also collected from domestic livestock for tritium analysis when tissue was not available from a particular area of interest or at a particular time of interest (for example: livestock near

the mouth of the Battlement Creek Valley immediately following a flaring operation). One hundred thirteen urine samples were collected from 20 residents in the area and analyzed for tritium.

Food crop sampling for Project Rulison

Samples of food crops were collected prior to the release of any gas to document background levels of tritium in these crops. These backgrounds ranged from 420 pCi/liter to 3100 pCi/liter of water with an average of 1300 pCi/liter. Following flaring, 24 samples of food crops, 7 samples of garden crops and 15 samples of orchard crops were collected and analyzed. There were no tritium concentrations above background levels. Detailed data are reported elsewhere (*1*).

Soil sampling for Project Rulison

Soil samples were collected prior to any release of gas to document background levels of tritium. For surface soil samples, these background levels ranged from less than 400 pCi/liter to 1400 pCi/liter of water with an average above the minimum detectable amount (MDA) of 1000 pCi/liter of water. For soil samples collected from a depth of 15 cm, the background ranged from less than 400 pCi/liter to 1100 pCi/liter of water with an average above the MDA of 750 pCi/liter of water. A total of 102 soil samples was collected during this 6-month period. Detailed data are reported elsewhere (*1*).

Dosimetry

Ninety-four dosimetry stations (figure 6)

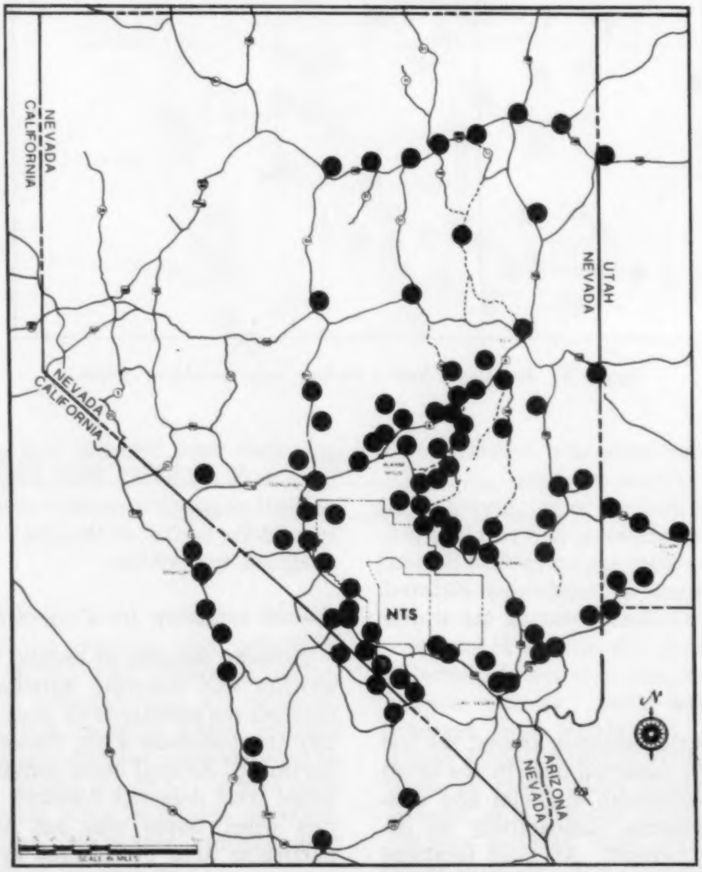

Figure 6. Routine dosimetry stations

located around the test range complex were equipped with three EG&G Model TL-12 thermoluminescent dosimeters (TLD) each, and about 60 offsite residents wore one TLD each. These TLD's were exchanged monthly. The TLD's have a uniform energy response from 50 keV to 1.25 MeV with a low energy cutoff at 50 keV. According to past TLD data, a reading at 5 mR above the previous month's background constitutes a detectable exposure. For the period of July to October 26, 24 TLD stations were located around the Project Rulison site. During this period, early snows made some stations inaccessible and the number of stations was reduced to 17. Due to low exposure rates, the network was further reduced to four close-in stations on December 1.

Community relations

Frequent contacts with the offsite population by NERC-LV field personnel and presentations for schools and civic groups provided the opportunity to explain the surveillance role of the EPA and the AEC testing programs. A number of offsite residents took part in the environmental sampling program. All routine air sampling stations except the one at Las Vegas were operated by local citizens.

Medical and veterinary services

A NERC-LV medical officer was available in the event complaints of a medical nature arose as a result of the nuclear testing program. He also provided liaison with local physicians. Veterinary officers of the NERC-LV Radiological Research Program provided a complete veterinary response capability. These officers, familiar with the livestock and dairy industries, wildlife, prevalent diseases, and poisonous plants in the area around NTS, maintained liaison with State and federal regulatory officials, local practioners, county agents, fish and wildlife officials, and other agricultural leaders. The program has two specially-equipped trucks capable of supporting field diagnoses and post mortems.

Analytical procedures

Analytical procedures are described in NVO 28 (*2*).

Results

A summary of monitoring results obtained for those operations resulting in a release of radioactivity to the offsite areas is presented here. Detailed data are reported separately (*1–3*). Routine surveillance network reports are available from the NERC-LV.

Project Rulison

The Project Rulison flaring operations during this 6-month period were conducted on the dates summarized in table 1.

Table 1. Summary of Project Rulison flaring operations

Flaring period	Start date (1970)	End date (1970)	Volume gas flared (Mm^3 standard)
Preliminary flow tests[a]	8/1	8/22	0.03
Calibrated tests[b]	10/4	10/07	.34
High rate	10/27	11/03	3.1
Intermediate rate	12/1	12/20	2.8

[a] Nine short runs up to 8 hours duration.
[b] Three short runs up to 14 hours duration.

Table 2 shows the total number of samples collected during this report period. Tritium and krypton-85 were the primary radionuclides released by the flaring operations. All environmental samples, except for the particulate air filters and charcoal cartridges, were analyzed for tritium. The natural gas samples, cryogenic samples, and compressed air samples were also analyzed for krypton-85.

Table 2. Project Rulison offsite environmental sampling[a]

Sample type	Total number of samples
Air (particulate filters)	1 059
Air (charcoal cartridges)	360
Atmospheric moisture (molecular sieve)	212
Natural gas	14
Cryogenic (ground)	2
Compressed air (ground)	8
Compressed air (aerial)	21
Atmospheric moisture (freeze out)	30
Water	251
Precipitation	119
Milk	62
Natural vegetation	95
Soil	102
Food crops	95
Cow feed	55
Urine (residents)	113
Urine (EPA monitors)	94
Animal tissue and blood	17

[a] Tritium levels above normal background that were related to Project Rulison were detected in all types of offsite samples except water, milk, urine, animal tissue, food crops, and cow feed. Particulate filters and charcoal cartridges were not analyzed for tritium. The highest concentrations of tritium in offsite atmospheric moisture samples are shown in table 3.

Tritium levels above normal background that

were related to Project Rulison were detected in all types of offsite samples except water, milk, urine, animal tissue, food crops and cow feed. Particulate filters and charcoal cartridges were not analyzed for tritium. The highest concentrations of tritium in offsite atmospheric moisture samples are shown in table 3.

Table 3. Five highest tritium concentrations in a mospheric moisture samples, Rulison (molecular sieve collectors)[a]

Location (azimuth and distance from test well)	Date (1970)	Time (on-off)	Tritium (pCi/liter H_2O)	Concentration (pCi/m^3 air)
Special station A–IX (52°, 1.3 km)	10/5	0840–1040	59 000	290
Special station A–X (65°, 1.0 km)	10/5	0835–1035	51 000	240
Special station A–VII (15°, 1.3 km)	10/5	1452–1553	43 000	220
Special station A–X (65°, 1.0 km)	10/5	1450–1550	34 000	180
Special station A–IX (52°, 1.3 km)	10/5	1455–1555	27 000	150

[a] Tritium concentrations in atmospheric moisture samples from the Rulison area had a background range from 500 pCi/liter H_2O to 2 600 pCi/liter H_2O. The average was 1 000 pCi/liter H_2O. The AEC standard (AEC Manual, Chapter 0524) for continuous exposure of the general population to tritium is 67 000 pCi/m^3 of air.

Krypton-85 was detected in natural gas samples and in compressed air samples. The five highest concentrations of krypton-85 detected offsite in compressed air samples on the ground are listed in table 4. Background levels of krypton-85 in the Rulison area ranged from less than 5 pCi/m^3 to 14 pCi/m^3 of air with an average of 12 pCi/m^3.

Table 4. Five highest krypton-85 results for compressed air samples[a]

Location (azimuth and distance from test well)	Sampling period		krypton-85 concentration (pCi/m^3 air)
	Date (1970)	Time (on-off)	
Old control point pad (325°, 3.9 km)	10/28	0645–0710	47
Special station D–1 (286°, 7.4 km)	12/6	0851–0916	27
Special station D–11 (328°, 6.8 km)	12/3	1955–2025	20
Special station D–29 (76°, 26.5 km)	10/27	1720–1750	14
3 miles south of Rifle Airport (65°, 20.9 km)	12/70	1535–1600	12

[a] The AEC standard (AEC Manual, Chapter 0524) for the continuous exposure of the general population to krypton-85 is 1×10^5 pCi/m^3 air.

Baneberry, December 18, 1970

The Baneberry Event was an underground nuclear weapons test conducted at the NTS on December 18, 1970. Shortly after the detonation, fission products escaped into the atmosphere and were carried over the offsite area. A radiological monitoring program was conducted by the NERC-LV detected radioactivity in environmental media in a widespread area of the western United States.

External gamma exposures

All offsite external gamma exposure rate measurements at inhabited locations were less than 1 mR/h. The highest measured exposure rate at an unpopulated location was 1.2 mR/h about 1.6 km east of Queen City Summit on Highway 25.

Based on a $t^{-1.2}$ extrapolation of rate-meter data, an estimate of 36 mR as the highest estimated infinity exposure at a populated location (Clark Station) was reported in a final report (*3*). An algorithm was later developed, based on a generalized decay scheme of ground-deposited Baneberry activity. This algorithm provided extrapolation factors which indicated that 13 mR was a more appropriate estimate. From this algorithm for all measurements, the highest estimated infinite external gamma exposure at an inhabited location was determined to be 16 mR at Blue Jay Highway Maintenance Station, 106 km northeast of Tonopah, Nev., on Highway 6. Figures 7, 8, and 9 show the monitoring results from D—Day to D+10.

Environmental sampling

Figures 10 and 11 show the locations where environmental samples were collected and whether radionuclides were detected. The six water samples containing radioiodine were from open supplies not used for human consumption. The total number of each type of environmental sample collected is listed in table 5.

Table 5. Baneberry environmental samples

Type	Number of samples	Type	Number of samples
Milk	496	Precipitation	118
Water	92	Natural vegetation	72
Air (particulate filters)	225	Cow feed	118
Air (charcoal cartridges)	243		

Air sampling results

Table 6 shows the five highest air sampling

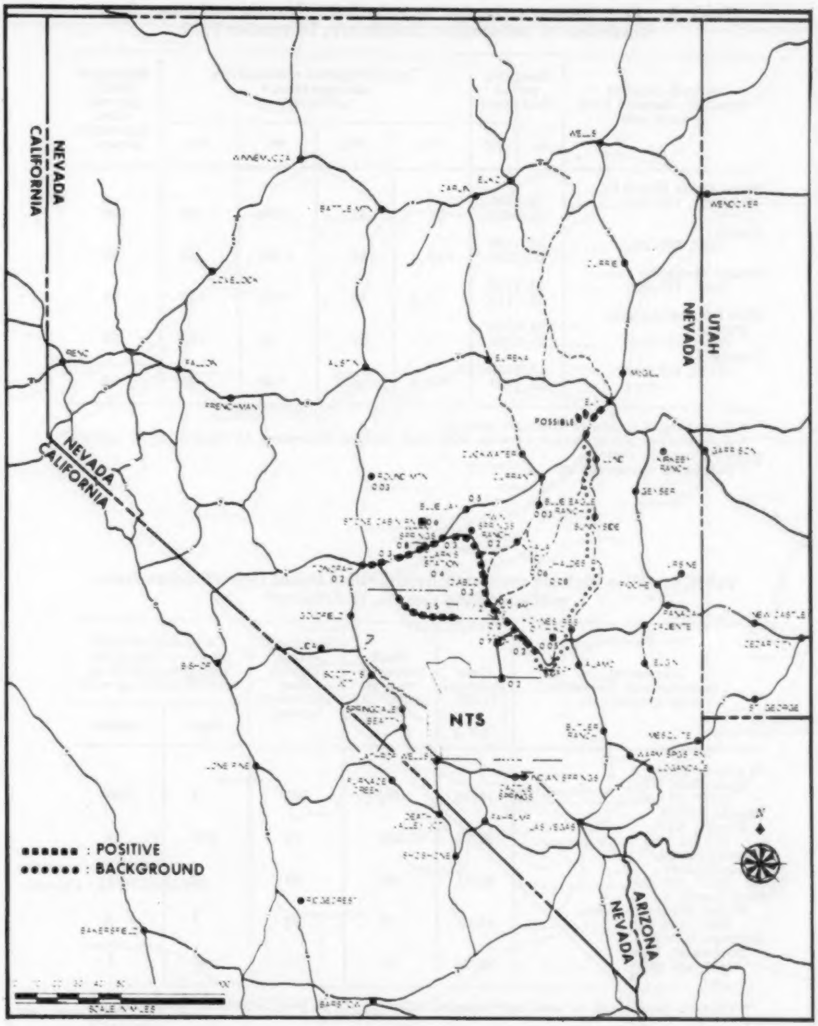

Figure 7. Area monitored and highest exposure rates (mR/h)-Nevada, Baneberry D-Day (12/18/70)

results ranked on the basis of maximum estimated thyroid dose to a hypothetical infant receptor with a 2-gram thyroid.

Milk sampling results

Table 7 shows the five highest milk sampling results ranked on the basis of the maximum estimated thyroid dose to a hypothetical infant receptor with a 2-gram thyroid. A 2-year-old child, living in Beatty, Nev., actually consuming milk from the McCurdy ranch was estimated to have received a dose of 130 mrem. The higher doses at the McCurdy ranch were the result of the cows grazing on pasture, whereas cows at other locations were eating hay. For the other ranches, the quantity of milk consumed by the youngest child drinking milk at each location was assumed to be 1 liter/day. The thyroid weights assumed for the 7- and 9-year-old children were 7 grams and 9 grams,

Table 6. Five highest estimated hypothetical infant thryoid doses from inhalation of radioiodine, Baneberry, December 1970

Nevada location (azimuth, distance from ground zero)	Sampling period date/time on	off	Time integrated radioactivity concentration [a] (μCi-s/m^3) ^{131}I	^{132}I	^{133}I	^{135}I	Estimated infant thyroid dose equivalent (mrem)
Stone Cabin Ranch [b] (337°, 120 km)	18/0800	30/0800	21	71	[c] 280	[c] 150	100
Austin (342°, 270 km)	18/1100	23/1000	[c] 12	31	[c] 150	50	53
Round Mountain (334°, 191 km)	18/1146	26/1140	7.4	18	[c] 85	[c] 27	31
Blue Jay maintenance station (356°, 137 km)	18/0740	28/0730	7.1	21	56	[c] 22	23
Tonopah (315°, 142 km)	18/1130	26/1400	[c] 4.5	[c] 8.2	[c] 48	35	19

[a] Extrapolated to end of collection periods.
[b] An electrical power failure between 0700 and 1200 on December 19 resulted in no sample collected for that period.
[c] Estimated concentration.

Table 7. Five highest estimated hypothetical infant thyroid doses from milk sampling results, Baneberry[a]

Location (azimuth and distance from ground zero)	Date collected (1970)	Peak concentration of iodine-131 (pCi/liter)	Estimated infant thyroid dose equivalent (mrem)	Estimated thyroid dose equivalent to youngest individual actually drinking milk (age)	(mrem)
McCurdy Ranch Springdale, Nev., (245°, 66 km)	12/26	810	260	2	130
Martin Ranch Eureka, Nev., (3°, 261 km)	12/22	240	40	>20	4
Young's Ranch Austin, Nev., (341°, 270 km)	12/21	140	30	9	7
Berg Ranch Round Mountain, Nev., (334°, 191 km)	12/21	70	20	7	5
Halstead Ranch Duckwater, Nev., (11°, 195 km)	12/20	90	10	>20	1

[a] Thyroid doses based on total milk samples collected, not on peak iodine-131 concentration.

respectively. A 20-gram thyroid weight was used for the adults. The thyroid dose equivalents received by the individuals were estimated from these assumptions, the concentrations of radioiodine in the milk and dose conversion factors.

Precipitation sampling results

Table 8 shows the five highest precipitation samples ranked by their concentrations of iodine-131. Normally, precipitation would not be of importance in terms of dose estimates. However, eight sheepherders working in an area between Duckwater and Eureka, Nev., were using melted snow for domestic purposes. Although no samples of the snow-water being used by the herders were collected, inference from samples collected around the area supports an estimated thyroid dose of 0.5 rem ± a factor of 3. The large error in the estimate is due to a number of uncertainties such as the geo-

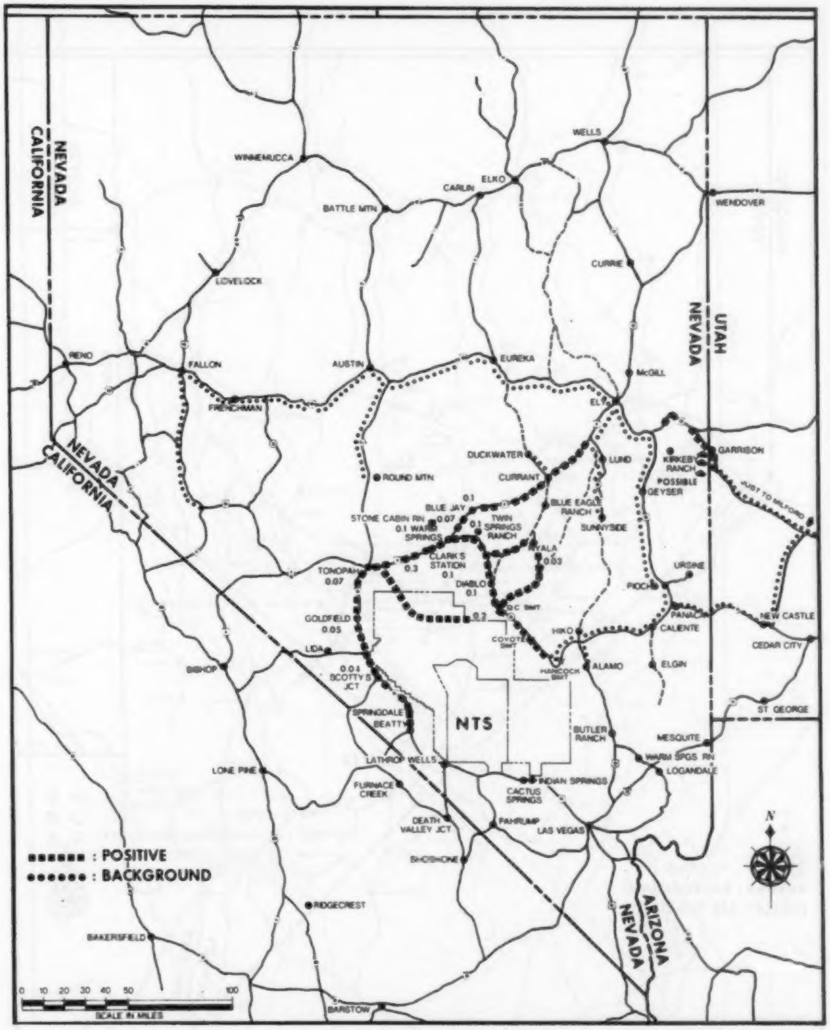

Figure 8. Area monitored and highest exposure rates (mR/h)-Nevada, Baneberry D+1 (12/19/70)

graphical distribution of fallout, snow collection techniques, the dilution by new snowfall, the actual water content of snow, and whether the radioactivity was deposited on the surface by fallout or snowout.

Summary

Tritium released by the July through December 1970 flaring operations at Project Rulison was detected in all types of environmental samples collected on the ground in offsite areas except for milk, water, food, food crops, cow feed, urine, and animal tissue. The highest concentration of krypton-85 in air was less than 0.05 percent of the AEC standard, and the highest tritium concentration in air samples was less than 0.5 percent of the AEC standard for air in the AEC Manual, Chapter 0524 (4).

The only NTS event that released radioactivity into the offsite environment during this

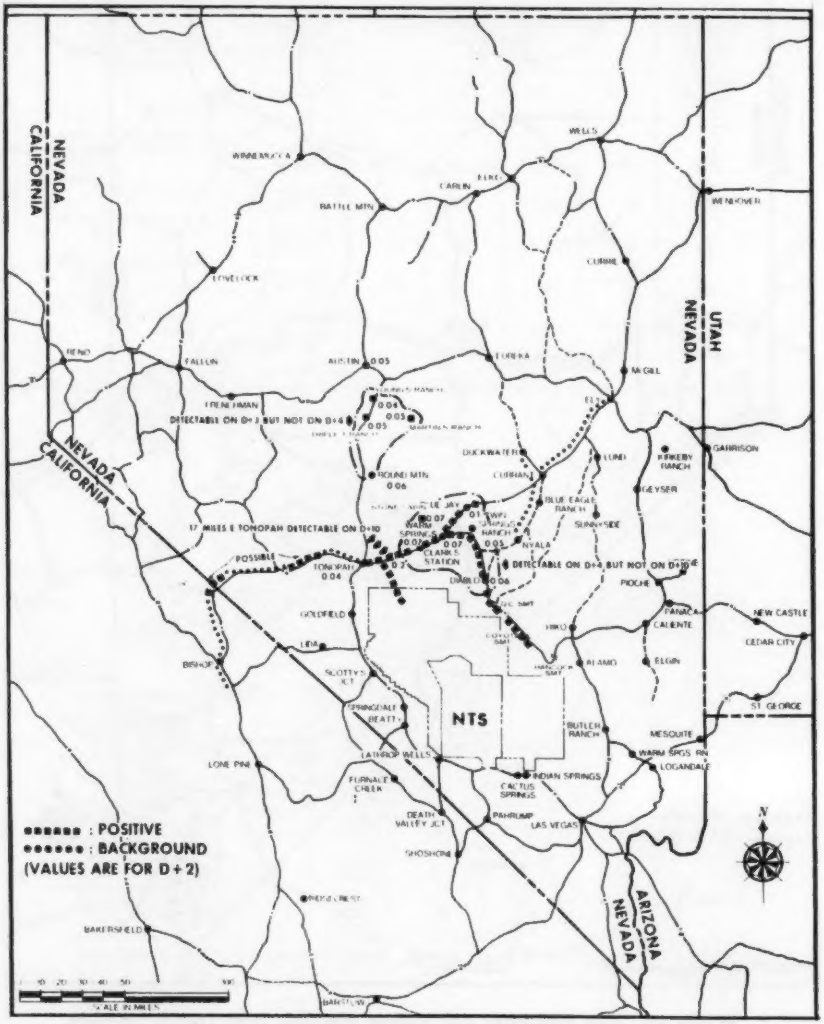

Figure 9. Area monitored and highest exposure rates (mR/h)-Nevada, Baneberry D+2-10 (12/20/70)

reporting period was Baneberry, on December 18, 1970. Figure 12 summarizes the combined estimates of hypothetical infant thyroid doses which were calculated from measured concentrations of airborne radioiodine, concentrations of radioiodine in milk, and external gamma radiation exposures. As shown by figure 12, the combined thyroid doses were below 0.5 rem, the radiation protection standard of AEC Manual, Chapter 0524 for thyroid doses to a representative population sample.

The highest estimated thyroid dose for Bane-

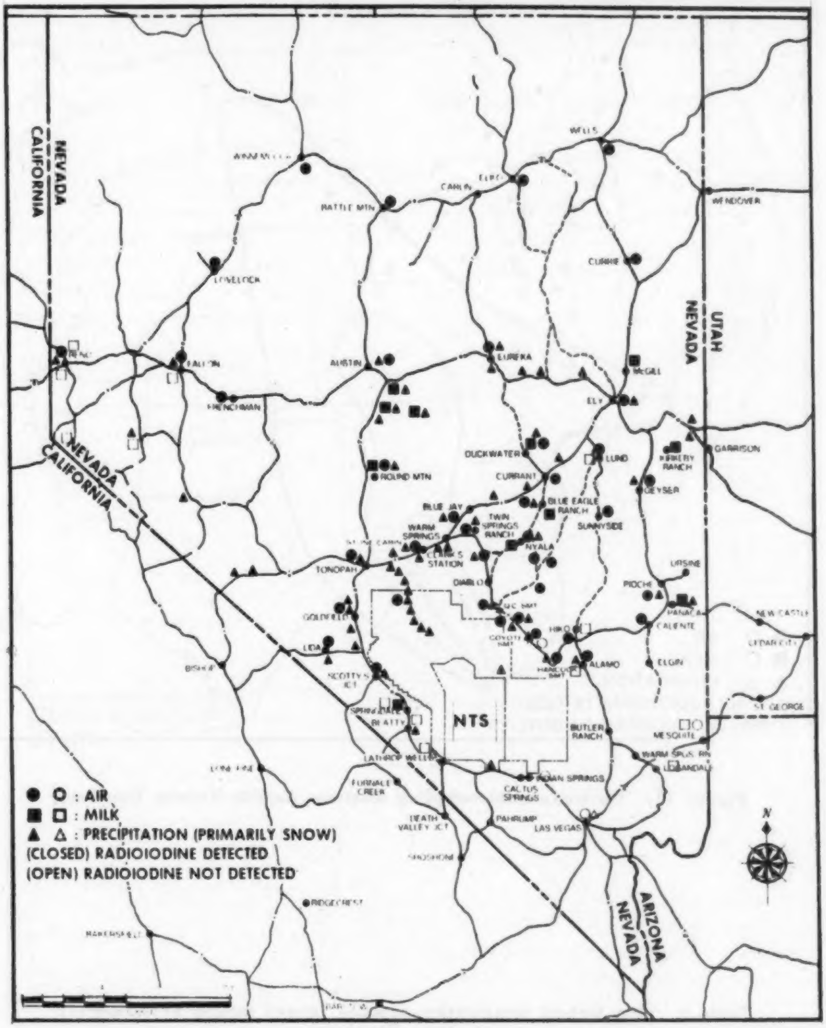

Figure 10. Environmental sampling locations in Nevada, Baneberry

berry was for the sheepherders who were working between Eureka and Duckwater, Nev., and using snow for cooking and drinking. Although no snow being used by the herders was collected, inference from samples collected around the area supports a thyroid dose estimate of 0.5 rem ± a factor of 3, which is within the radiation protection standard (4) of 1.5 rem to the thyroid of an individual within the general population.

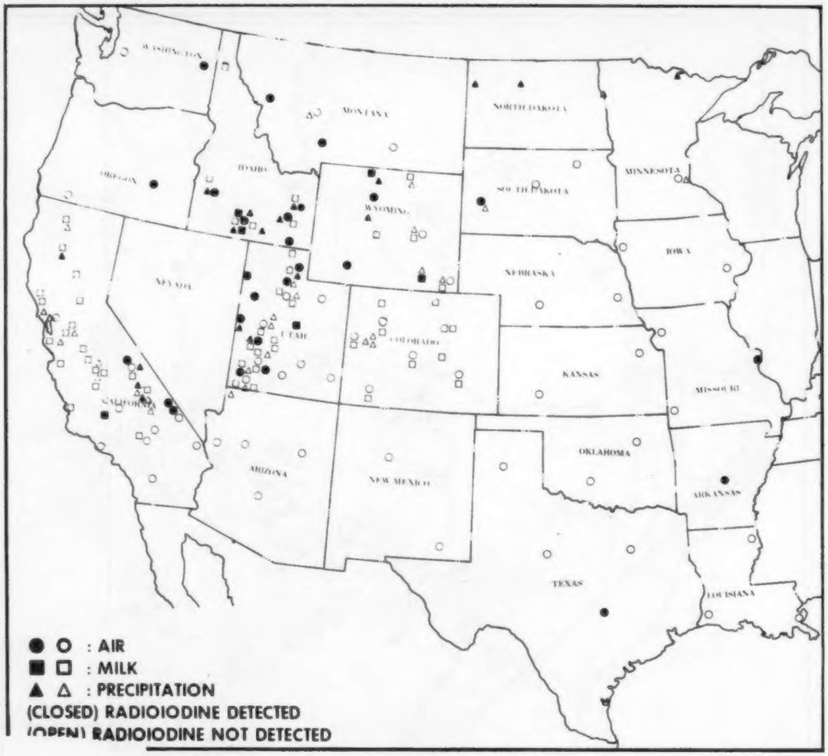

Figure 11. Environmental sampling locations outside Nevada, Baneberry

Table 8. Five highest precipitation samples (snow) ranked by iodine-131 concentrations, Baneberry

Location (azimuth and distance from ground zero)	Date collected (1970)	Radionuclide concentration [a] (μCi/liter)			
		Iodine-131	Tellurium-132	Iodine-133	Iodine-135
Blue Jay maintenance station (355°, 142 km)	12/19	0.32	1.9	2.2	ND
24 km S junction highway 6 and TTR road (324°, 116 km)	12/19	.22	1.5	1.9	ND
48 km SW of Currant, Nev. on highway 6 (4°, 154 km)	12/20	.21	.99	.78	ND
Queen City Summit on highway 25 (8.5°, 71 km)	12/19	.20	.99	.54	.42
16 km S junction highway 6 and TTR road (323°, 122 km)	12/20	.19	.92	.92	ND

[a] Other radionuclides were detected but were not germane to thyroid dose calculations.
ND, nondetectable.

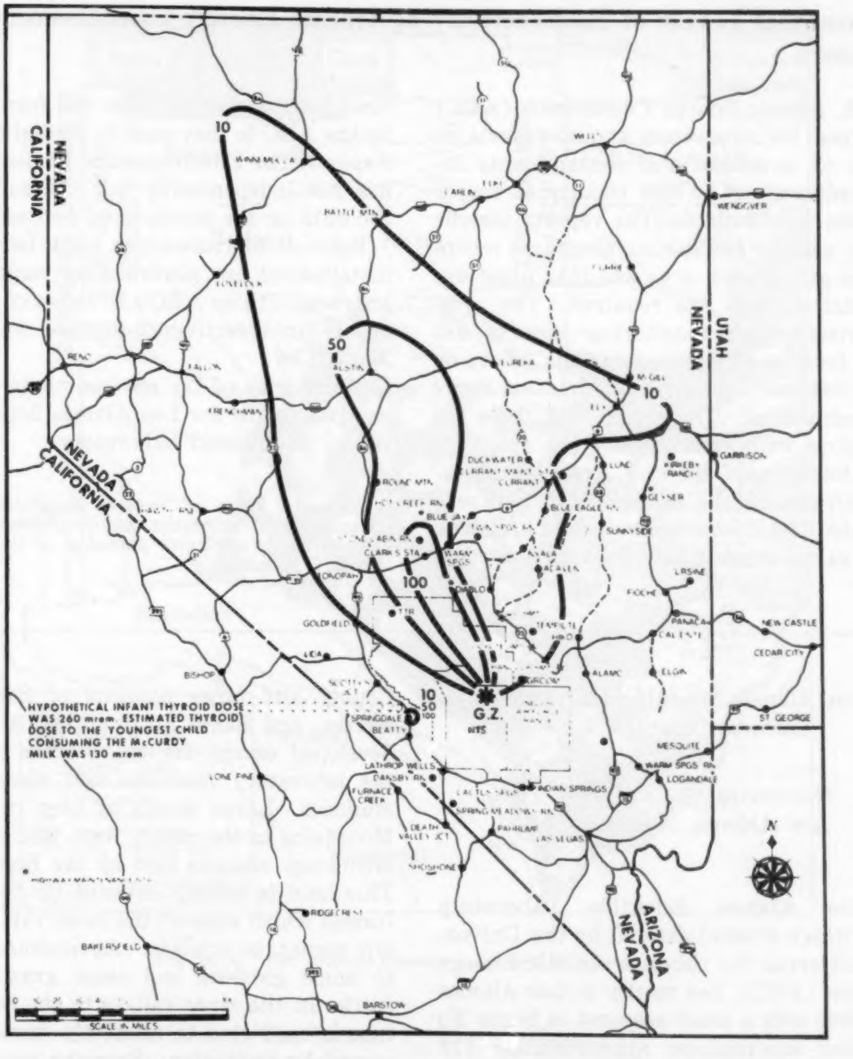

Figure 12. Distribution of total estimated infant thyroid dose (mrem) in Nevada, postulated for hypothetical receptors exposed to measured radiation levels and concentrations in air and milk

REFERENCES

(1) PAYNE, D. W. and F. GROSSMAN. Off-site radiological safety program for Project Rulison re-entry portion of Phase III, NERC-LV-539-14 (November 1972); BOYSEN, G. The flaring portion of Phase III, Project Rulison, NERC-LV-539-15 (to be published).

(2) U.S. ATOMIC ENERGY COMMISSION. Safety involving detonation of nuclear devices, NVO-28, Chapter 11. U.S. Atomic Energy Commission, Nevada Operations Office, Las Vegas, Nev. (May 1966, revised 1968).

(3) WESTERN ENVIRONMENTAL RESEARCH LABORATORY. Final report of off-site surveillance for the Baneberry event, December 18, 1970, SWRHL-107r. Environmental Protection Agency, Western Environmental Research Laboratory, Las Vegas, Nev. (February 1972).

(4) U.S. ATOMIC ENERGY COMMISSION. Standards for radiation protection, AEC Manual, Chapter 0524. U.S. Atomic Energy Commission Washington, D.C. 20545 (November 8, 1968).

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission (AEC) receives from its contractors annual reports on the levels of environmental contaminants including radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required. The complete environmental monitoring reports are available from local AEC operations offices or from the National Technical Information Service at nominal cost. The portions of these reports dealing with radioactivity are summarized for *Radiation Data and Reports.* Statements interpreting the radioactivity data are those of the USAEC contractors. The units for the data as reported in the individual reports have been converted from the format required by the AEC to that used by *Radiation Data and Reports.* The Environmental Protection Agency has not independently nor critically reviewed the data or the conclusions derived therefrom.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual." [1]

Summaries of the environmental radioactivity data follow for Los Alamos Scientific Laboratory and Mound Laboratory.

[1] Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation" contains essentially the standards published in Chapter 0524 of the AEC Manual.

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1. Los Alamos Scientific Laboratory[2] Calendar Year 1972

University of California
Los Alamos, New Mex.

The Los Alamos Scientific Laboratory (LASL), which is administered by the University of California for the U.S. Atomic Energy Commission (AEC), lies mostly in Los Alamos County, with only a small segment in Santa Fe County, and encompasses approximately 113 km^2. This parcel of AEC-controlled land contains all of the laboratory technical areas (figure 1).

The laboratory and community at Los Alamos are located on the Pajarito Plateau, situated west of the Rio Grande on the eastern slopes of the Jemez Mountains in north-central New Mexico. This land was originally chosen for its relative isolation. Thus, the area surrounding Los Alamos, including all of Los Alamos County and large portions of Sandoval, Rio Arriba, and Sante Fe Counties, is largely undeveloped except for those areas occupied by the laboratory facilities and associated communities. Large tracts of land in the Jemez Mountains to the north, west, and south of the laboratory site are held by the Forest Service. This land is largely covered by fir and aspen forests which support the usual variety of western mountain wildlife. Agriculture is limited to home gardens and some grazing of beef cattle. In the river valleys to the east, agriculture is restricted to relatively small plots supported by irrigation. Primary crops are chili peppers, tree fruits, and alfalfa. Milk is not produced in commercial quantities in the immediate vicinity of Los Alamos. The technical areas are principally located on the mesa tops with the interspersed canyons serving as separation areas, although a few have been located at the bottoms of steep, narrow canyons for isolation and safety purposes.

[2] Summarized from Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites—Calendar Year 1972.

Airborne effluents

The major sources of airborne contaminants at LASL and the amounts of effluent from each

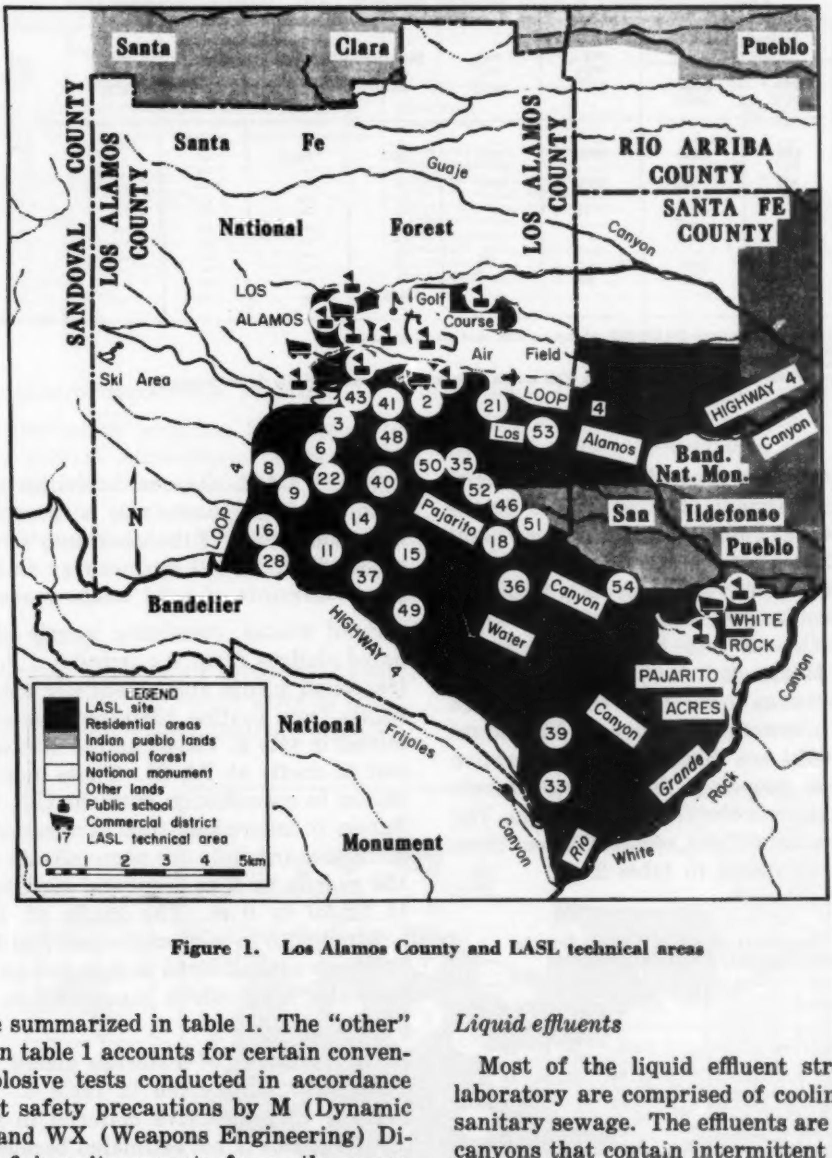

Figure 1. Los Alamos County and LASL technical areas

source are summarized in table 1. The "other" category in table 1 accounts for certain conventional explosive tests conducted in accordance with strict safety precautions by M (Dynamic Testing) and WX (Weapons Engineering) Divisions at firing sites remote from other occupied laboratory sites and from residential areas. Most of the debris from these tests is deposited in the immediate vicinity of the prepared firing site, and little of the hazardous material is widely dispersed into the environment. A program to measure these dispersal fractions is currently under review, but execution will depend on funding and availability of manpower.

Liquid effluents

Most of the liquid effluent streams of the laboratory are comprised of cooling water and sanitary sewage. The effluents are released into canyons that contain intermittent streams that recharge water in the alluvium. This water is depleted by evaporation and transpiration and does not reach the Rio Grande. None of the effluent streams recharges aquifers from which municipal, industrial, or irrigation waters are drawn.

The primary contaminated, or potentially contaminated, liquid effluents from LASL operations are collected by an elaborate system of

Table 1. Summary of major airborne effluents, LASL, January-December 1972

Technical area	Unidentified		^{238}Pu, ^{239}Pu (µCi)	^{234}U, ^{235}U (µCi)	Depleted ^{238}U [c] (µCi)	^{131}I (Ci)	^{88}Rb, ^{138}Cs (mCi)	^{133}Xe, ^{135}Xe (Ci)	^{41}Ar (Ci)	^{3}H (Ci)
	Alpha [a] (µCi)	Beta [b] (µCi)								
2	—	—	—	—	—	—	47	720	640	—
3	680	6700	7900	100	260	7400	—	—	—	48
9	—	—	—	—	—	—	—	—	—	70
21	<1	<1	2800	1200	—	—	—	—	—	—
33	—	—	—	—	—	—	—	—	—	2900
35	—	—	18	—	—	—	—	—	—	2500
41	10	—	—	—	—	—	—	—	—	110
43	5	—	—	—	—	—	—	—	—	—
46	—	—	—	120	—	—	—	—	—	—
48	—	2700	110	8	—	—	—	—	—	—
50	—	140	27	—	—	—	—	—	—	—
Other	—	—	—	—	[d] 870	—	—	—	—	1800

[a] Primarily thorium-232, uranium-234,235,238, plutonium-238, and americium-241.
[b] Primarily mixed fission products.
[c] Depleted uranium of varying compositions.
[d] Kilograms, correspond to approximately 0.32 Ci. This amount not completely dispersed into the environment.

acid sewers and are treated at the industrial liquid waste treatment plant at TA–21 or the central industrial liquid waste treatment plant at TA–50. Effluents from the TA–21 treatment plant are released into DP Canyon, a tributary to Los Alamos Canyon, and the effluents from TA–50 are released into Effluent Canyon, a tributary to Mortandad Canyon. Only waters with concentrations lower than those listed in table 2 (i.e., in uncontrolled areas), AEC Manual Chapter 0524 are released, but evaporative and adsorptive processes tend to concentrate the contamination in the channel alluvium. The amounts of radionuclides released from these two sources are shown in table 2.

Table 2. Summary of major liquid effluents LASL, January-December 1972

Contaminant	TA–21	TA–50
Volume discharged 10^6 liters	8.8	57
Radioactivity: (mCi)		
Gross alpha	.93	14
Plutonium-238	.16	7.7
Plutonium-239	.10	1.0
Gross beta	16	380
Strontium-89	.65	3.5
Strontium-90	1.0	5.5
Tritium	3 600	6 000

Solid waste

Although the disposal of solid radioactive wastes is not directly pertinent to an environmental monitoring program, wastes improperly controlled in disposal could have a most significant environmental impact. A short summary of LASL disposal activities is included here for this reason, and to present a more complete picture of the laboratory's waste treatment effort, as well as to convey an idea of the actual amounts of solid waste generated.

Solid wastes, consisting mostly of contaminated sludges from the industrial liquid waste treatment plants and potentially contaminated refuse from routine laboratory operations, are buried in pits at TA–54 on the Mesita del Buey and in shafts at TA–21. These locations were chosen in consultation with the U.S. Geological Survey to assure long-time localization of radioactivity. Large pits are nominally 30 m wide by 180 m long by 9 m deep, and smaller ones are 15 by 90 by 9 m. The shafts at TA–21 are nominally 2.5 m in diameter and 5 to 20 m deep. They are asphalt-lined and do not penetrate to the water table, which is over 350 m below the surface at TA–21.

The quantities of materials placed in storage during 1972 are given in table 3. The total quantity of radioactive material in several of the categories is not estimated because individual consignments are below the limits of detection for any device to measure gross activity, and to multiply the large waste volumes by any assumed value for the possible concentration of radioactivity would be false and misleading. Laboratory accountability procedures, developed over many years, give assurance that only small quantities of radioactive materials are contained in laboratory trash and scrap.

Table 3. Summary of solid waste disposal, LASL, January-December 1972

Nature of waste	Container or stabilizer	Estimated volume (liters)	Estimated activity (Ci)
Contaminated sludge from TA-50 liquid waste treatment plant	Metal drums	260 000	9
Contaminated sludge from TA-21 liquid waste treatment plant [a]	Cement paste	530 000	300
Hot cell and glovebox wastes containing uranium, plutonium, and fission products	Metal containers, wooden crates	16 000	79
Activated metal	Metal containers	340	15
Tritium and tritium contaminated wastes	Metal containers, concrete	8 700	2000
Uranium and uranium contaminated wastes	Metal containers, wooden crates	39 000	Not estimated
Plutonium and plutonium contaminated wastes	Metal containers, wooden crates	83 000	Not estimated
Contaminated animal tissue	Cardboard boxes	450	Not estimated
Low level sources	Metal containers	350	<1
Laboratory trash	Cardboard boxes, plastic bags	1 800 000	Not estimated
Metal scrap	Not packaged	1 600 000	Not estimated
Classified	Metal drums	16 000	Not estimated

[a] Placed in shafts at TA-21.

Atmospheric monitoring program

The air monitoring program is designed to provide for general surveillance of the levels of gross alpha and beta radioactivity in air, the concentrations of those specific radionuclides directly associated with laboratory operations, and the concentrations of certain nonradioactive materials.

Daily air sampling

An air sampler drawing air through a 78-mm Microsorban filter having an efficiency of about 99.8 percent for 0.3-μm dioctylphthalate (DOP) particles (a standard test aerosol for determining filter efficiency) and an 80-mm Welsh charcoal respirator cartridge at a rate of approximately 200 liters/min is maintained on the roof of Building LD–1, TA–50. The filter and the canister are changed daily. The particulate material on the filter is measured on the day of collection for gross alpha and beta emissions on an alpha-beta gas flow proportional counter and again 7 to 10 days after collection to measure long-lived activity. The initial measurements of the gross alpha and beta emissions provide an early detection of

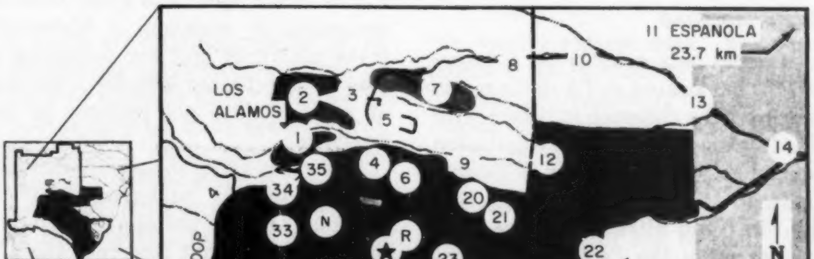

Figure 2. Locations of atmospheric monitoring stations, Los Alamos

high activities relative to natural background levels. The 7-day measurements, after the decay of radon and thoron daughters, are used as the official records of activity. The alpha activity is consistently at or near the MDL of the system, approximately 1 fCi/m^3, and is not reported here. The sensitivity of the system is adequate to give early warning of a significant accidental release, should one occur. The long-lived gross beta activity measurements for 1972 are comparable with national samples collected by the Environmental Protection Agency (EPA) (*1*), and follow cyclic trends established by past years' data (*2,3*). This trend is due to seasonal changes in atmospheric mixing that bring fission products from past atmospheric weapons testing to the ground. The pronounced peaks in mid-January and late March are the results of Chinese atmospheric nuclear tests of January 7 and March 18.

The activity collected by the charcoal canister is measured by gamma-ray spectrometry for iodine-131. None of the charcoal cartridges contained iodine-131 at a level of more than 10 fCi/m^3, the estimated MDL of the system. Locations of atmospheric monitoring stations are shown in figure 2.

Daily deposition sampling

Deposition of gross beta activity on a 0.4-m^2 precipitation collector located at TA–50 is measured each workday. The collector is rinsed with water combined with whatever precipitation may have been collected. This water is filtered through a Whatman 41 filter and the gross beta activity of the filter and filtrate are measured separately to determine the "soluble" component of the deposition activity. This separation is conducted to provide data for other studies, however, and for surveillance purposes, the two results are added and reported as total gross beta activity. A measurement is made immediately to augment the daily air sample data and again after 7 days to represent the long-lived gross beta activity free of radon and thoron products.

Weekly air sampling

The main air monitoring program consists of a weekly sample collection from 35 continuous air sampling stations. An extensive revamping in 1971 resulted in a network that required no major changes during this reporting period, and virtually the entire array was operative during the entire period, giving 51 weekly samples for all but a few stations. Each station consists of a pump that pulls air through a Microsorban filter and a Welsh charcoal cartridge similar to those used to collect the daily sample. During the latter part of this reporting period, a program to replace some of the older and more troublesome pumps with new pumps of higher capacity and requiring less maintenance resulted in two different flow rates. The flow rate as measured by rotometers, was 70 liters/min except for six new pumps whose rate was 200 liters/min.

On the first and tenth day after collection, each filter is measured simultaneously for gross alpha and beta activities by a gas flow proportional counter. The first-day count is for 30 minutes, and the tenth-day count is for 90 minutes. Results of gross measurements on weekly air filters are shown in table 4.

Gross activity

The gross alpha and gross beta activities are measured to maintain a historical record of these activities and for screening of the samples to detect unexpectedly high concentrations of radionuclides not covered by more specific analyses.

The gross alpha measurements have been corrected both for background of the counting chamber and for the approximately 0.1 percent of beta counts that feed into the alpha channel of the counter (cross-talk). Background, i.e., count of an unused filter (blank), normally runs 33 counts/90 minutes. A filter from the sampling array can thus be distinguished from the blank if it contains a total activity of more than 44 counts/90 minutes. Consideration of total flow through the filter yields an MDL of about 0.2 fCi/m^3 for the total collection (old pumps) and analysis procedure.

The average gross alpha measurements for the 35 stations were higher than those reported previously; however, the increase was not due to local sources, but to the 1972 Chinese tests.

Table 4. Results of gross measurements on weekly air filters, LASL, January-December 1972

Station	Gross alpha concentration (fCi/m^3)		Gross beta concentration (fCi/m^3)	
	Maximum	Average [a]	Maximum	Average [a]
Offsite:				
1	4.2	1.6±0.2	1.68	0.19±0.08
2	3.6	1.6± .3	2.19	.18± .09
3	4.6	1.5± .3	1.55	.20± .10
4	4.7	1.6± .3	2.44	.19± .10
5	4.5	1.7± .3	1.83	.19± .09
6	6.0	1.4± .3	2.20	.20± .10
7	3.6	1.6± .2	1.99	.19± .09
8	4.8	2.0± .3	2.60	.18± .10
9	6.4	1.9± .4	1.95	.20± .10
10	4.6	1.9± .3	3.19	.20± .13
11	6.2	[b] 2.1± .5	2.57	[b] .19± .11
12	7.6	1.6± .4	1.65	.19± .08
13	4.7	1.7± .3	2.94	.19± .12
14	3.7	1.7± .2	1.59	.22± .10
15	4.3	1.6± .3	1.64	.18± .07
16	7.2	[c] 2.0± .4	1.92	[c] .18± .08
17	4.2	1.3± .3	1.90	.19± .08
18	4.5	1.4± .2	2.19	.18± .09
19	4.4	1.5± .2	3.27	.18± .08
Onsite:				
20	2.8	1.3± .2	1.41	.17± .06
21	7.5	2.2± .4	1.86	.19± .09
22	5.3	1.5± .3	1.76	.18± .08
23	9.5	[b] 1.6± .4	1.87	[b] .20± .09
24	4.0	1.5± .2	2.08	.20± .10
25	4.5	1.6± .3	1.77	.18± .07
26	3.5	1.1± .2	2.03	.17± .09
27	9.8	1.9± .6	3.27	.21± .13
28	3.5	1.3± .2	2.14	.20± .10
29	4.4	1.5± .3	2.32	.19± .10
30	3.7	1.2± .2	2.08	.18± .08
31	4.7	1.5± .3	2.27	.19± .10
32	3.4	1.1± .2	1.76	.18± .08
33	5.2	1.5± .3	2.15	.20± .10
34	4.0	1.5± .3	1.94	.17± .08
35	5.3	1.5± .3	2.14	.18± .09

[a] Average and 95-percent confidence limits for the average.
[b] One sample lost.
[c] Two samples lost.

The maximum alpha activity observed at every station occurred during the detection of one or the other of the two Chinese tests. Because of the difficulty in determining when the effects of these tests had become negligible, all values were included in the averages given in the table. No local releases of significant magnitude were observed. Spatial variations in gross alpha activity measured at all 35 stations can be described by a log normal distribution (normal distribution of the logarithms of the numbers) and its associated random fluctuations. This lack of significant station effects, along with the small range in concentrations, leads one to conclude that the laboratory has little influence on the level of this activity.

The gross beta averages, given in table 4, are higher than previously reported. Again, the maximums, and hence the inflated averages, were due to Chinese tests, and no local discharges were observed. The seasonal trend, reported previously (*2,3*) was also observed with the weekly sample data. Results of measurements at all 35 stations are again log normally distributed, reflecting the small influence of laboratory activities on this level.

The gross beta measurements were corrected only for counter background because the cross-talk from the alpha channel is negligible. Background levels for the counter (blank count of 680/90 minutes), together with sampling techniques, result in an estimate of 0.7 fCi/m^3 for the MDL of the gross beta activity.

The charcoal cartridges collected with the weekly particulate samples are analyzed for iodine on a gamma-ray spectrometer. Analysis of the cartridges indicated that iodine-131 could not have been present at concentrations above 10 fCi/m^3, the estimated MDL of the system.

Plutonium and americium

The weekly filters, after being measured for gross alpha and beta activities, are combined

Table 5. Plutonium and americium concentrations in air, LASL, January-December 1972

Station	Concentration (aCi/m³)					
	Plutonium-238		Plutonium-239		Americium-241	
	Maximum	Average	Maximum	Average	Maximum	Average
Offsite:						
1	34	17	363	69	—	—
2	194	32	160	47	—	—
3	350	41	117	40	—	—
4	117	31	104	43	—	—
5	70	24	191	50	—	—
6	33	14	108	35	—	—
7	37	15	148	46	—	—
8	73	19	87	36	—	—
9	209	28	265	73	—	—
10	68	25	197	47	—	—
11	19	14	108	38	—	—
12	136	29	122	37	—	—
13	31	16	126	47	—	—
14	46	19	89	41	—	—
15	99	22	186	61	—	—
16	26	[b] 14	73	[b] 33	80	[a] 27
17	48	19	105	38	—	—
18	59	[b] 17	144	[b] 31	—	—
19	36	[b] 16	101	[b] 28	—	—
Onsite:						
20	176	31	112	53	—	—
21	53	19	148	45	178	44
22	42	17	113	32	—	—
23	81	25	112	43	—	—
24	241	34	106	38	—	—
25	47	17	143	37	—	—
26	51	12	136	45	—	—
27	37	18	99	37	—	—
28	49	19	89	32	61	22
29	52	20	241	56	—	—
30	59	18	99	30	87	33
31	94	21	101	34	—	—
32	58	21	76	36	97	40
33	133	28	930	117	—	—
34	404	80	224	58	88	[b] 32
35	257	50	122	50	—	—

[a] Includes one 3-week sample and twelve 4-week samples.
[b] One sample lost.
[c] Two samples lost.

to represent a 4-week sample from each station and are analyzed radiochemically for plutonium-238, -239. Composite 4-week samples from 6 of the stations are also analyzed for americium-241. The MDL is about 0.1 fCi/m³ for each of the three isotopes. These concentrations are summarized in table 5. At least one measurement at each station fell below the MDL.

The plutonium-238 levels measured during this period followed established patterns. The highest concentrations occurred north and east of TA–21 and the CMR Building (TA–3) where releases of filtered process air containing traces of plutonium occurred.

The maximum plutonium-238 onsite average concentration, 80 aCi/m³ at station 34 (TA–3) was 0.004 percent of the 2 pCi/m³ concentration guide value for the soluble form of the isotope, as listed in AEC Manual Chapter 0524, for a controlled area. The maximum offsite average concentration, 41 aCi/liter at station 3, Los Alamos Golf Course, was 0.06 percent of the 70 fCi/m³ value for uncontrolled areas. The maximum 1-month concentration occurred at this same station and was 0.5 percent of the uncontrolled area guide value. The highest average for the 35 stations occurred during the period in which the debris of the March 18 Chinese atmospheric nuclear test was detected. The overall average annual concentration for the 35 stations of the LASL air sampling network as 24 aCi/m³ as compared to an average annual value of 3.8 aCi/m³ for 10 reporting stations of the EPA Radiation Alert Network (4–7) across the United States during 1971.

The plutonium-239 measurements, not easily represented pictorially, also relate to the plutonium emissions from the CMR Building and TA–21. The maximum onsite average concentration, 120 aCi/m³ at station 33, TA–6, was 0.006 percent of the AEC Manual Chapter 0524 guide limit of 2 pCi/m³ for the soluble form of

the isotope for controlled areas, and the maximum offsite average concentration, 73 aCi/m^3 at station 9, Los Alamos Airport, was 0.1 percent of the 60 fCi/m^3 guide limit for uncontrolled areas. The maximum offsite average for a given month, 360 aCi/m^3, occurred at station 1, Diamond Drive, and was only 0.6 percent of the uncontrolled area guide value. The overall average annual concentration for all 35 stations was 45 aCi/m^3 compared to an average value of 50 aCi/m^3 for the 10 reporting stations of the EPA Radiation Alert Network.

The highest average americium-241 concentration of the six stations routinely measured (44 aCi/m^3) occurred at station 21, TA–53, the station closest to TA–21, where americium-241 emissions may be expected in association with plutonium. This value was less than 0.001 percent of the AEC Manual Chapter 0524 concentration guide value of 6 pCi/m^3 for the soluble form of the isotope. The effort directed at measurement of this isotope will be studied in greater detail during 1973 in order to develop a more comprehensive program.

Table 6. Tritiated moisture and total moisture and total uranium concentrations in air, LASL, January-December 1972

Station	Tritiated moisture (pCi/m^3)		Total uranium (pg/m^3)	
	Maximum	Average	Maximum	Average
Offsite:				
1	83	25	100	90
2	43	21	90	70
3	77	22	180	110
4	120	29	80	60
5	87	29	170	110
6	94	31	180	100
7	71	23	110	60
8	80	23	120	90
9	190	36	80	60
10	86	23	150	80
11	36	20	180	110
12	57	24	90	60
13	68	22	130	80
14	65	21	100	70
15	89	25	120	80
16	46	21	90	80
17	68	23	110	70
18	650	44	90	60
19	60	22	170	90
Onsite:				
20	120	36	100	70
21	180	33	120	70
22	110	33	110	60
23	700	110	140	70
24	110	32	80	70
25	210	48	90	60
26	150	29	130	60
27	2 300	180	120	90
28	77	28	110	60
29	53	21	240	120
30	48	24	80	60
31	42	21	70	60
32	120	31	90	60
33	84	29	80	60
34	160	33	60	50
35	83	28	70	60

Uranium

An aliquot of each of the 4-week composite samples was saved to form a 12-week composite which was analyzed fluorometrically for uranium. The MDL of the system, which does not distinguish separate uranium isotopes, is about 50 pg/m^3. Although depleted uranium is involved in LASL explosive tests, there does not appear to be a station effect with distance from the areas of the explosive testing. The concentrations, given in table 6, are approximately 50 percent lower than those reported for the last 6 months of 1971.

Tritium

In addition to the particulate sample and the iodine-131 sample, a separate sample is collected at each station every week for tritium measurement. Air is drawn through a tube of silica gel dessicant at an average flow of approximately 50 ml/minute. This procedure permits water vapor collection at about 95-percent efficiency. The water vapor is collected by heating the dessicant and condensing the resulting vapor. A standard aliquot of this water is analyzed for tritium content by liquid scintillation counting and the resulting figure is combined with the average humidity for the week to obtain an estimate of the average tritiated vapor content per unit volume of air. The collection system and counting procedure result in an MDL of approximately 5 pCi/m^3 (50 percent relative humidity, 9°C temperature, 750 mbar pressure).

Measurements of tritiated water vapor in air are summarized in table 6. At least one measurement at each station fell below the MDL. As expected, the highest concentrations were near TA–33 and TA–35 due to tritium releases (table 1). The highest average for an onsite station, which occurred at station 27, TA-33, was 0.004 percent of the concentration guide value for controlled areas (5 $\mu Ci/m^3$), as listed in AEC Manual Chapter 0524. The highest average for an offsite or uncontrolled area occurred at station 9, Los Alamos Airport and was 0.02 percent of the AEC recommended guide of 0.2 $\mu Ci/m^3$ for uncontrolled areas.

External radiation monitoring program

A thermoluminescent dosimeter (TLD) array is maintained to monitor gamma and x radiation at natural background levels to provide information on any possible contribution from laboratory activities.

Each of the 59 stations in the array is composed of three Harshaw TLD–100 chips. These are cut from single crystals of LiF (natural lithium) and are 3.18 mm square by 0.89 mm thick, with a mass of 23 to 24 mg. The three chips are wrapped together in aluminum foil and put in a 17-mm diameter by 50-mm long cylindrical polyethylene container for placement in the field. The TLD's in the field are exchanged with fresh ones at regular periods and the thermoluminescence is measured by means of an Eberline TLR–5 reader. The exposure of each chip is inferred, using identical calibration chips that have received known exposures from a cobalt-60 source under controlled conditions. The average of the three exposures is then taken to give the total exposure for the period of the exchange at the particular station.

The stations were operated on a 4-week exchange schedule for the first 24 weeks of 1972, starting January 12. Operating experience revealed that the exchange interval could be relaxed to 12 weeks for 45 of the 59 stations. The last exchange for which data are available for this report took place December 12, giving 48 weeks of data for the year.

In general, there was very little temporal variation in exposure rate, which remained fairly constant over the year at approximately 13 mR/month.

Total exposures for calendar year 1972 at the 59 TLD stations in the Los Alamos area were estimated from the 48 weeks of data and are presented in table 7. The spatial variation can be accounted for by statistical fluctuations about a central mean value, except for five stations. These stations, one offsite and four onsite, are discussed later and are excluded from the following argument. It can be shown statistically that these exposures fit a log normal distribution function reasonably well, a result consistent with the results of many other environmental measurements. A geometric mean of 147 mR and a geometric standard deviation of 1.17 (multiplicative) are obtained for the 21 offsite stations, with corresponding values of 160 mR and 1.14 for the 33 onsite stations under consideration. Furthermore,

Table 7. Summary of thermoluminescent dosimeter readings, LASL, January-December 1972

Station	Exchange interval (wk)	Annual exposure (mR)
Offsite:		
1	12	130
2	12	146
3	4	124
4	12	156
5	12	141
6	12	196
7	12	153
8	4	133
9	12	194
10	12	148
11	4	187
12	12	137
13	12	111
14	12	179
15	12	141
16	4	141
17	12	138
18	4	127
19	12	145
20	4	123
21	12	174
22	4	229
Average[a]		147
Range		137–157
Onsite:		
23	12	117
24	4	203
25	12	124
26	4	139
27	12	135
28	12	244
29	12	173
30	12	152
31	12	188
32	12	189
33	4	597
34	12	188
35	4	339
36	12	174
37	12	215
38	12	236
39	12	174
40	12	155
41	12	153
42	12	181
43	12	161
44	4	193
45	12	151
46	12	153
47	12	152
48	12	166
49	4	162
50	12	158
51	12	147
52	12	156
53	12	167
54	12	134
55	12	163
56	4	157
57	12	150
58	12	162
59	12	149
Average[a]		160
Range		152–168
All stations:		
Average[a]		155
Range		149–161

[a] Geometric mean. Range gives the 95-percent confidence limit for the average, and was calculated from the geometric standard deviation. Stations 22, 28, 33, 35, and 38 are not included in these calculations.

these means are statistically equal at the 95 percent level of confidence, so that the entire group of results may be adequately described by a single log normal distribution with a geometric mean of 155 mR and a standard deviation of 1.16. The lack of significant station effects indicates that this level of external radiation is caused by natural terrestrial and solar sources, the variation being due to the random nature of these sources. For comparison, TLD-measured exposure at Colorado Springs (elevation 1880 m) is reported (*8*) to be about 143 mR/yr, and the range at locations closer to sea level is likely to be 25 to 80 mR/yr, depending on geology.

The single offsite station not included in the above discussion is located at the headquarters complex of Bandelier National Monument (station 22). This station indicated slightly higher levels than the other stations during the July–December 1971 reporting period as well. None of the air samples collected at the same station indicated any unusually high levels of airborne radioactivity. It is very doubtful that the response to the TLD's at this station is due to laboratory activities. It is probably due to a combination of two effects: first, a slightly higher than normal contribution from naturally occurring terrestrial gamma-emitting radionuclides; and second, the geometry of the station. The station is located next to an adobe-brick wall at the bottom of a 175-m deep canyon which is about 350 m wide.

Of the four onsite stations mentioned above, two stations: 33, TA–18 and 35, TA–36; are positioned so as to monitor TA–18. Their reresponse is due solely to operation at TA–18 of fast burst reactors (research reactors that are operated in such a manner as to provide very short and very intense bursts of neutrons). A third, station 38, TA–39 is located near the base of a cliff approximately 75 m high. No air sampler is located at this station for comparison, but the somewhat elevated level reported during 1971 indicates that terrestrial sources, mentioned in the preceding paragraph, could quite possibly account for the high measurement. The cause of the high measurement at the remaining station, station 28, Highway 4, is unexplained. No air sampler is located there, and a high TLD indication was not reported during 1971. It is doubtful that laboratory activities influenced either of the latter two results. The three stations whose results are not clearly understood will be studied further by use of field instrumentation and by small displacements of the TLD packets from their usual positions.

Water monitoring program

The water monitoring program is designed for surveillance of the Los Alamos municipal water supply drawn from the deep aquifer underlying the laboratory area, as well as for general surveillance of the ground and surface waters in the vicinity. Samples from supply wells are collected at the individual wellheads during pumping, and samples of surface water are bailed from a convenient pool or allowed to flow directly in to the sample container. For samples from observation holes and test wells, sufficient water is drawn and discarded to make the sample representative of the ground water at the time of sampling. All samples are analyzed by radiochemical methods for gross alpha, beta, and gamma activities and for tritium, plutonium, and cesium-137. A fluorometric technique is used to measure uranium concentration.

The plutonium determination performed on these water samples deserve special mention because tenuous identifications of trace amounts of this material were made on several occasions. These identifications are believed to be due to cross-contamination in the analytical laboratory or to fluctuations of the MDL, both very real problems at the low concentrations being investigated here. Thus, those samples in which traces of plutonium were found are reported, although they are probably not indicative of actual plutonium contamination of the water from which they were taken. Verification will depend upon patterns established by analyses of future sample collections.

Los Alamos water supply

During 1972, about 6.8 billion liters of water were supplied to Los Alamos from 16 supply wells ranging in depth from 265 to 795 m and from one gallery which has been developed on the eastern flanks of the Jemez Mountains.

Table 8. Analyses of Los Alamos water system samples, LASL January-December 1972

Determination and units	Number of samples	Range			Detection limit
		Maximum	Minimum	Average	
Gross alpha (pCi/liter)	35	20	<2.0	<2.1	1.0
Gross beta (pCi/liter)	35	11	<1.0	<3.0	1.0
Plutonium-238 (fCi/liter)	36	<50	<50	<50	50
Plutonium-239 (fCi/liter)	36	<50	<50	<50	50
Cesium-137 (pCi/liter)	35	<350	<350	<350	350
Tritium (nCi/liter)	35	<1.0	<10	<1.0	1.0
Total uranium (ng/liter)	35	25 000	<200	<2900	200

These sources, as well as two test wells, were sampled to monitor the quality of water in the main aquifer. The range and average of constituents in this water are given in table 8.

There is a slight variation in water quality from periods of light pumpage (winter) to periods of heavy pumpage (summer).

Regional surface waters

Offsite rivers and reservoirs in and adjacent to the Los Alamos area are sampled and analyzed routinely to provide information on general water quality in the area and to serve as background for other measurements. During this period, 16 water samples were collected at four river stations: the Rio Chama at Chamita, and the Rio Grande at Embudo, Otowi, and Cochiti (figure 3). Sixteen water samples (two at each station) were taken from the other stations at Caliente River, Santa Cruz Reservoir, Tesuque Creek, Galisteo Reservoir, the Rio Grande at Bernalillo, Jemez Creek, Fenton Lake, and Abiquiu Reservoir. Only one sample was collected from Jemez Reservoir. These nine stations are 35 to 50 km from the approximate center of the LASL site.

The range and average of constituents of water from these sampling stations are shown in table 9. The quality of this water fluctuates drastically due to variations in discharge and in size and terrain of the drainage area. Jemez Reservoir was dry when visited in early summer. In late fall, a sample of base flow was collected from the channel below the reservoir. The water was highly mineralized (dissolved solids 1430 μg/ml), as were both samples from Galisteo Reservoir (dissolved solids 158 μg/ml and 3030 μg/ml). The high mineral concentrations in these waters are due to the small dilution by runoff of the base flow which leaches minerals from the "red bed" terrain that constitutes most of the drainage area of these two streams. Traces of plutonium-238 were reported in water collected from the Caliente River in the spring and in both samples of water collected from Santa Cruz Reservoir collected in the spring and fall. Again, identification of plutonium-238 is tenuous at these low levels.

Figure 3. Locations of regional surface water, sediment, and soil sampling stations, Los Alamos

Table 9. Analysis of water from regional sampling stations, LASL January-December 1972

Determination and units	Number of samples	Range			Detection limit
		Maximum	Minimum	Average	
Gross alpha (pCi/liter)	33	11	<1.0	<2.0	1.0
Gross beta (pCi/liter)	33	17	<1.0	<5.0	1.0
Plutonium-238 (fCi/liter)	33	120	<50	<60	50
Plutonium-239 (fCi/liter)	33	<50	<50	<50	<50
Cesium-137 (pCi/liter)	33	<350	<350	<350	< 350
Tritium (nCi/liter)	33	12	<1.0	<2.0	1.0
Total uranium (ng/liter)	33	26 000	<200	<3 800	200

Surveillance water sampling

Samples of surface and ground water were collected and analyzed to help assess the overall impact of laboratory operations on the environment. Sampling locations are shown in figure 4.

The offsite monitoring consisted of collection of two water samples each from Los Alamos Spring and Basalt Spring, and one sample each from the stream in Frijoles Canyon and from Los Alamos Reservoir (table 10). The onsite monitoring consisted of collection of one sample of surface water each from Cañada del Buey, Pajarito Canyon, and Water Canyon (table 11). No results were abnormal for these stations (*2,3*).

Sediment monitoring program

Sediments are those earthen materials that have been transported and reworked by surface water. Samples were collected at the nine 35- to 50-km-distant stations from which regional surface water samples were obtained. In addition, samples were taken for surveillance from canyon stream beds in the vicinity of the laboratory at the stations shown in figure 3. Some of these sources are natural streams flowing either perennially or intermittently during the rainy season, and some are streams produced by effluents from laboratory or municipal facilities. Sediment samples from perennial streams were taken from dunes built up in eddies behind boulders in the main channel.

Table 10. Analyses of offsite surface and ground water, LASL, January-December 1972

Determination and units	Los Alamos Spring	Basalt Spring	Frijoles Canyon	Los Alamos Reservoir	Detection limit
Number of samples:	2	2	1	1	
Gross alpha (pCi/liter)	2.0	<1.0	<1.0	<1.0	1.0
Gross beta (pCi/liter)	4.0	4.0	1.0	<1.0	1.0
Plutonium-238 (fCi/liter)	<50	<50	<50	<50	50
Plutonium-239 (fCi/liter)	<50	<50	<50	<50	50
Cesium-137 (pCi/liter)	<350	<350	<350	<350	350
Tritium (nCi/liter)	<1.0	<1.0	<1.0	<1.0	1.0
Total uranium (ng/liter)	4600	3000	1300	1500	200

Table 11. Analyses of onsite surface water, LASL, January-December 1972

Sample determination and units	Canada del Buey	Pajarito Canyon	Water Canyon	Detection limit
Number of samples:	1	1	1	
Gross alpha (pCi/liter)	<1.0	<1.0	<1.0	1.0
Gross beta (pCi/liter)	2.0	3.0	3.0	1.0
Plutonium-238 (fCi/liter)	<50	<50	<50	50
Plutonium-239 (fCi/liter)	<50	<50	<50	50
Cesium-137 (pCi/liter)	<350	<350	<350	350
Tritium (nCi/liter)	1.0	3.0	<1.0	1.0
Total urnaium (ng/liter)	1800	3100	1300	200

From the intermittent streams, samples were collected across the main channel to a 2-cm depth and a 7.5-cm scoop. In still water, the samples were dredged from the bottom with a bailer at some convenient point. The samples were placed in a new polyethylene container for storage and transported to the laboratory. Samples were leached with acids, and determinations of gross alpha and beta activities, plutonium, cesium, and uranium were made on the acid leach.

Regional sediments

Sediments were collected and analyzed from the regional surface water sampling stations to provide general data on the quantities of radioactive material in the environment beyond the general laboratory area. Results of the analyses are given in table 12.

Surveillance sediment sampling

Locations of sediment sampling stations are shown in figure 4. Results of the analyses for onsite and offsite samples are given in table 13. In general, the results from this sampling program were consistent with previously reported values (*2,3*). Concentrations of plutonium lie in the range expected to result from worldwide fallout. One onsite sample exhibited a high uranium concentration, probably due to the fact that it was collected in an area where explosive tests could be expected to disperse uranium locally.

Soil monitoring program

Soils are those earthen materials that are weathered in place. They are sampled primarily to indicate the possibility of deposition of con-

Table 12. Analyses of regional sediment samples, LASL, January-December 1972

Determination and units	Number of samples	Range			Detection limit
		Maximum	Minimum	Average	
Gross alpha (pCi/g)	7	3.1	<1.0	<1.4	1.0
Gross beta (pCi/g)	7	14	<3.0	8.0	3.0
Plutonium-238 (fCi/g)	9	9.0	<3.0	<4.1	3.0
Plutonium-239 (fCi/g)	9	25	<3.0	<6.6	3.0
Cesium-137 (pCi/g)	9	7.8	2.0	4.0	2.0
Total uranium (ng/g)	9	700	230	420	10

Table 13. Analyses of surveillance sediment samples, LASL, January-December 1972

Determination and units	Number of samples	Range			Detection limit
		Maximum	Minimum	Average	
Offsite stations:					
Gross alpha (pCi/g)	4	2.5	<1.0	<1.4	1.0
Gross beta (pCi/g)	4	12	3.8	6.8	3.0
Plutonium-238 (fCi/g)	4	<3.0	<3.0	<3.0	3.0
Plutonium-239 (fCi/g)	4	26	<3.0	<8.8	3.0
Cesium-137 (pCi/g)	4	9.1	2.8	5.2	2.0
Total uranium (ng/g)	4	620	450	540	10
Onsite stations:					
Gross alpha (pCi/g)	3	2.6	<1.0	<1.5	1.0
Gross beta (pCi/g)	3	14	4.5	8.5	3.0
Plutonium-238 (fCi/g)	3	7.6	3.0	<4.5	3.0
Plutonium-239 (fCi/g)	3	4.1	<3.0	<3.6	3.0
Cesium-137 (pCi/g)	3	4.8	4.5	4.6	2.0
Total uranium (ng/g)	3	5200	90	1900	10

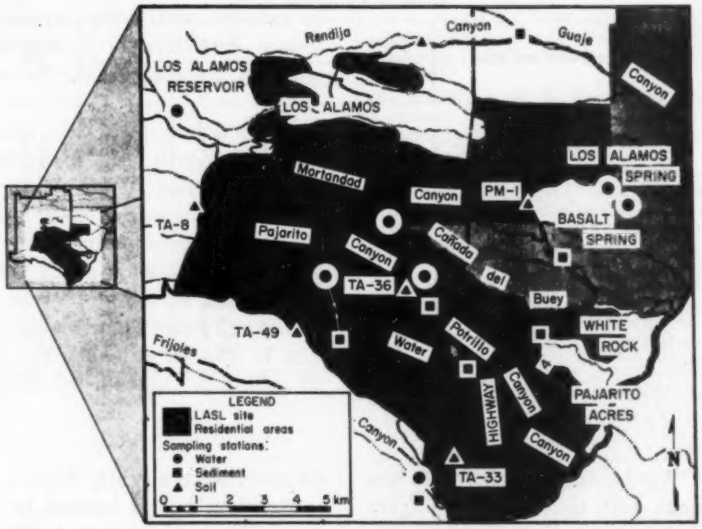

Figure 4. Locations of surveillance water, sediment, and soil sampling stations, Los Alamos

taminants from the atmosphere. Samples are collected by taking five plugs, 7.5 cm in diameter and 5 cm deep, at the corners and center of a square that is 10 m on a side. The five plugs are combined into a single composite sample and analyzed for gross alpha and beta activities, plutonium, cesium, tritium, and uranium, using basically the same techniques as for sediment samples. Samples were taken at the regional surface water stations (figure 3) and at stations established for general surveillance in the vicinity of Los Alamos.

Regional soils

A summary of the results from the samples taken at distances of 35 to 50 km from the center of the laboratory area is given in table 14. The values are in line with those expected from natural radioactivity and from worldwide fallout from past weapons tests (*9*).

Surveillance soil sampling

A summary of the results from the samples taken in the vicinity of Los Alamos County is

Table 14. Analyses of regional soil samples, LASL, January-December 1972

Determination and units	Number of samples	Range			Detection limit
		Maximum	Minimum	Average	
Gross alpha (pCi/g)	9	5.8	<1.0	<1.9	1.0
Gross beta (pCi/g)	9	18	6.2	9.7	3.0
Plutonium-238 (fCi/g)	9	10	<3.0	<4.4	3.0
Plutonium-239 (fCi/g)	9	14	4.0	8.8	3.0
Cesium-137 (pCi/g)	9	11	3.2	4.8	2.0
Tritium [a] (nCi/liter)	9	6.2	<3.0	<3.5	3.0
Total uranium (ng/g)	9	780	90	420	10

[a] Soil moisture distilled from sample.

Table 15. Analyses of surveillance soil samples, LASL, January-December 1972

Determination and units	Number of samples	Range			Detection limit
		Maximum	Minimum	Average	
Offsite stations:					
Gross alpha (pCi/g)	4	3.8	2.3	2.6	1.0
Gross beta (pCi/g)	4	17	4.7	12	3.0
Plutonium-238 (fCi/g)	4	<3.0	<3.0	<3.0	3.0
Plutonium-239 (fCi/g)	4	19	9.0	15	3.0
Cesium-137 (pCi/g)	4	8.4	5.9	7.2	2.0
Tritium [a] (nCi/liter)	4	5.7	<3.0	<4.0	3.0
Total uranium (ng/g)	4	970	150	380	10
Onsite stations:					
Gross alpha (pCi/g)	2	2.3	1.0	1.7	1.0
Gross beta (pCi/g)	2	12	<3.0	<7.5	3.0
Plutonium-238 (fCi/g)	2	<3.0	<3.0	<3.0	3.0
Plutonium-239 (fCi/g)	2	15	<3.0	<9.0	3.0
Cesium-137 (pCi/g)	2	7.1	4.3	5.7	2.0
Tritium [a] (nCi/liter)	2	<3.0	<3.0	<3.0	3.0
Total uranium (ng/g)	2	730	580	670	10

[a] Soil moisture distilled from sample.

given in table 15. Again, the values found are in general agreement with those expected from natural activity and worldwide fallout.

Discussion

The results of the monitoring program for this report period confirm the generally low radiation levels in the Los Alamos environs noted in previous periods. Measurements of the gross activities in air and precipitation indicate concentrations similar to those measured at other locations in the northern hemisphere where activity is entirely attributable to the presence of worldwide fallout. Airborne plutonium and tritium measurements reveal that laboratory activities have elevated slightly the levels of both materials above the concentrations expected from fallout due to past weapons testing and reentry and burnup of isotope power sources contained in space vehicles.

In the text, comparisons were made between observed concentrations and applicable guides for offsite and onsite areas, respectively. Since site boundaries are near some of the onsite stations used for these comparisons and since public use of adjacent roads is normally permitted (although use can indeed be restricted), comparisons are made in this section between onsite concentrations and offsite guides.

The highest average of total plutonium (plutonium-238 + plutonium-239) concentration at a station accessible to the public was 140 aCi/m^3 and occurred at Station 34, TA–3. (Station 33 recorded a slightly higher average total concentration, but is located in a remote area inaccessible to the public.) This combined onsite concentration is approximately 0.23 percent of the most restrictive guide value of 60 fCi/m^3 for the soluble form of plutonium-239 in uncontrolled areas.

During this reporting period, the highest average onsite tritiated moisture concentration in the Los Alamos area was 180 pCi/m^3, less than 0.1 percent of the guide value of 0.2 μCi/m^3 for uncontrolled areas. This concentration was sufficient to produce a whole-body dose of about 0.3 mrem, using the quality factor of 1.7 used in the derivation of the 1960 ICRP-NCRP maximum permissible concentration that apparently served as the basis for the AEC Manual Chapter 0524 concentration guides. If the quality factor of 1.0 now accepted by the ICRP and NCRP is used for these low-energy beta radiations, this dose is about 0.2 mrem. This may be compared with the radiation protection guide for annual dose to the whole body (AEC Manual Chapter 0524) of 500 mrem for an individual or 170 mrem for the most restrictive segment of the population.

External gamma- and x-radiation levels, as measured by the TLD array were comparable to those measured elsewhere at approximately the same elevation. This suggests that the predominant contribution to external dose is from cosmic and naturally occurring terrestrial sources.

The Los Alamos water supply remained uninfluenced by laboratory operations. Traces of plutonium were tenuously identified in water samples from two offsite bodies of surface water.

Small quantities of plutonium and some beta emitters, both a result of past disposal operations, were found in sediment collected in an offsite canyon. This area, although accessible to the public, is reasonably isolated, so that occupancy is limited to an occasional hiker or hunter. This low occupancy factor and/or the association of the material with large quantities of sediment would preclude the uptake of any significant quantities by people, animals, or plants.

Previous coverage in *Radiation Data and Reports:*

Period	Issue
January–December 1971	November 1973

REFERENCES

(*1*) NATIONAL ENVIRONMENTAL RESEARCH CENTER—LAS VEGAS. Air Surveillance Network, August 1972. Radiat Data Rep 13:704–707 (December 1972).

(*2*) HERCEG, J. E. Environmental monitoring in the vicinity of the Los Alamos Scientific Laboratory, January-June 1971, LA-4871-MS. Los Alamos Scientific Laboratory (1972).

(*3*) HERCEG, J. E. Environmental monitoring in the vicinity of the Los Alamos Scientific Laboratory, July-December 1971, LA-4970 (1972).

(*4*) EPA, OFFICE OF RADIATION PROGRAMS. Plutonium in airborne particulates, January-March 1971. Radiat Data Rep 12:584–585 (November 1971).

(*5*) EPA, OFFICE OF RADIATION PROGRAMS. Plutonium in airborne particulates, April-June 1971. Radiat Data Rep 13:159 (March 1972).

(*6*) EPA, OFFICE OF RADIATION PROGRAMS. Plutonium in airborne particulates, July–September 1971. Radiat Data Rep 13:221 (April 1972).

(*7*) EPA, OFFICE OF RADIATION PROGRAMS. Plutonium in airborne particulates, October-December 1971. Radiat Data Rep 13:412 (July 1972).

(*8*) JONES. D. E., C. L. LINDEKEN, and R. E. McMILLEN. Natural radiation background dose measurements with CaF_2:Dy TLD, UCRL–73432. Lawrence Radiation Laboratory (1971).

(*9*) KENNEDY, W. R. and W. D. PURTYMUN. Plutonium and strontium in soil in the Los Alamos, Espanola, and Santa Fe, New Mexico areas, LA–4562. Los Alamos Scientific Laboratory (1970).

2. Mound Laboratory[3] January–December 1972

Monsanto Research Corporation
Miamisburg, Ohio

Mound Laboratory is situated on 0.73 km^2 of land in Miamisburg, Ohio, about 19 km southwest of Dayton. The area within a 32 km radius of the laboratory includes essentially all of Montgomery County and approximately 30 to 60 percent of the adjoining counties of Butler, Greene, Preble and Warren. The predominant geographical feature in the five-county region is the Great Miami River which flows through Miamisburg from the northeast to the southwest. This river valley area is generally highly industrialized. The remainder of the region is predominantly agricultural with some light industry and scattered residential communities. The primary agricultural activity in the area is raising field crops such as corn and soybeans. Approximately 10 percent of the land area in agricultural use is devoted to pasturing livestock (*1*).

Weather conditions in the area are considered moderate. The average annual precipitation is approximately 91 cm and is evenly distributed throughout the year. Winds predominate out of the south and west except during the summer months when a higher frequency is observed out of the southwest. The wind speed averages about 16 km per hour annually (*2*).

Mound Laboratory began operation in 1949. Its mission currently includes research, development, engineering, and production of components for the AEC weapons program; research, development, and production of explosive materials; separation, purification, and sale of stable isotopes of the noble gases; and development, design, and fabrication of radioisotopic heat sources for medical application and space exploration. Radionuclides currently being worked with include plutonium-238, polonium-210 and tritium.

[3] Summarized from "Environmental Monitoring Report, 1972, Mound Laboratory."

Interest in the health and safety of employees and the public is manifested by an Environmental Control Program which has been in existence continuously during the laboratory's history. Fundamental objectives of the environmental control program are the containment of radioactive waste and control of nonradioactive effluents to levels well within existing or proposed standards. As part of the program's control function, all effluents containing polluting materials are controlled at each operating step. As a result of this control, any release of low-level gaseous and liquid wastes to the environment are carefully controlled and dispersed to ensure that concentrations are well within recommended standards.

Air monitoring

Mound Laboratory, through the AEC, has entered into a contractual agreement with the Montgomery County Combined General Health District (MCCGHD) for the installation and operation of a sampling network consisting initially of 10 offsite air sampling stations. Installation of the sampling stations was completed during February 1972. The sampling sites were located on the basis of a diffusion model (*3*) developed by the Dayton Laboratory of Monsanto Research Corporation. Five of the samplers are located within a 1.6 km radius of the laboratory perimeter. The remaining five samplers are located in adjacent population centers in the northeastern quadrant up to 16 km from the laboratory. The sampling sites are shown in figure 5. Eleven additional sampling stations will be completed during the first quarter of 1973. Two types of samples are collected: a particulate sample for plutonium-238 and polonium-210 analysis, and a gas bubbler sample for tritium oxide analysis.

The particulate sample is collected on a 200-mm-diameter Microsorban disk by means of a continuously operating high-volume air sampler. The air is sampled at the rate of 1 m^3/min. The Microsorban disk is changed weekly, which represents a sample of approximately 10 000 m^3 of air. Polonium-210 analyses are performed on a weekly basis while the plutonium-238 analyses are performed on a monthly composite sample. The plutonium-238 analysis

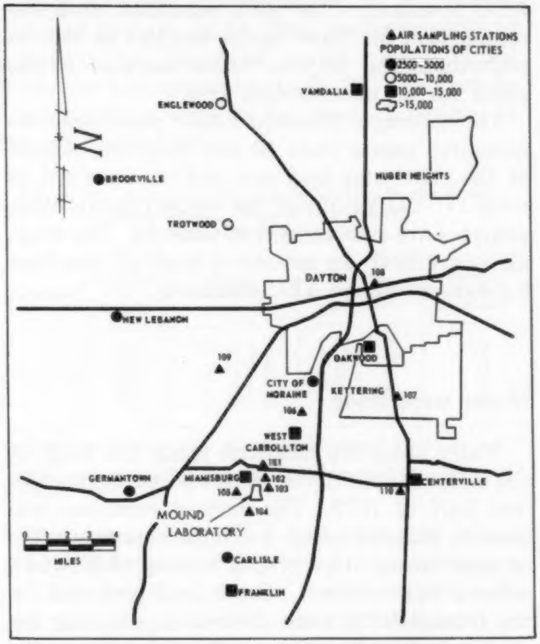

Figure 5. Offsite air sampling zones, Mound Laboratory

includes the use of plutonium-236 as an internal standard in conjunction with alpha pulse height analysis which allows correction for chemical and counting losses to be made. The results reported below represent total concentrations of the analyzed radionuclides including contributions from natural sources and atmospheric fallout.

Since commercial sales of polonium-210 from Mound Laboratory have ceased, and the concentration of polonium-210 measured in the atmosphere has significantly decreased, samples collected at only two offsite locations were analyzed for polonium-210 during 1972. If a significant increase in the concentration of polonium-210 is observed at these locations, additional analyses at other locations will be performed to assure that control of emissions is still effective (i.e., well within stringent AEC standards). The results of the polonium-210 analyses are summarized in table 16. Average concentrations measured were only 0.02 percent of the AEC standard.

Table 16. Atmospheric monitoring for polonium-210, Mound Laboratory, January-December 1972

Location	Number of samples	Range (fCi/m^3)	Average concentration[a] (fCi/m^3)	Percent of AEC standard[b]
Onsite:				
211	26	0.93–3.7	2.3 ±0.1	0.01
212	26	.70–2.4	1.3 ± .1	.006
213	26	.66–2.6	1.2 ± .1	.006
214	26	.74–4.5	1.3 ± .1	.007
215	26	.59–2.3	1.2 ± .1	.006
Offsite:				
101	46	.52–3.7	1.3 ± .1	.02
108	42	.6 –2.9	1.3 ± .1	.02

[a] Minimum detection limit (MDL) for polonium-210 in air is 0.02 fCi/m^3.
[b] The applicable AEC radiation protection standard for polonium-210 in air is 20 pCi/m^3 for onsite locations and 7 pCi/m^3 for offsite locations.

The average plutonium-238 concentrations were all less than 0.3 percent of the AEC standards. The AEC standards used for comparison is the guide for the soluble form of the isotope and for the general population. This is the most restrictive AEC standard for plutonium-238 and is applied since the solubility of the measured particles in the potential receptor (i.e., the human body) is unknown at this time. These results are summarized in table 17.

Table 17. Atmospheric monitoring for plutonium-238, Mound Laboratory, January-December 1972

Location	Number of samples	Range (aCi/m^3)	Average concentration[a] (aCi/m^3)	Percent of AEC standard[b]
Onsite:				
211	26	10 – 928	400 ±10	0.6
212	26	10 – 129	58 ± 4	.08
213	26	8 –1 101	400 ±10	.6
214	26	39 – 153	140 ± 6	.2
215	26	18 – 33	22 ± 2	.08
Offsite:				
101	46	11 – 95	34 ± 3	.2
102	[c] 3		69 ± 5	.3
103	44	4.7– 188	56 ± 4	.3
104	45	5.7– 51	20 ± 2	.1
105	45	3.8– 27	9.6 ± 1	.05
106	45	2.7– 78	13 ± 2	.07
107	25	2.2– 11	4.9 ± 1.3	.02
108	43	3.2– 14	7.7 ± 1.5	.04
109	41	2.4– 9.2	5.0 ± 1.3	.02
110	27	3.5– 7.3	5.1 ± 1.3	.03

[a] Minimum detection limit (MDL) for plutonium-238 in air is 0.5 aCi/m^3.
[b] The applicable AEC radiation standard for plutonium-238 in air is 70 fCi/m^3 for onsite locations and 20 fCi/m^3 for offsite locations.
[c] Combined to form a single, composite sample.

The gas bubbler sample is also collected on a continuous basis at approximately 3000 cm^3/min. The sample is collected by bubbling air through 500 ml of a water-ethylene glycol mixture. Any tritium oxide present in the air is

collected in the solution. The ethylene is added to the water to lower both its vapor pressure and freezing point. The sampling and analysis are directed to tritium oxide rather than elemental tritium since the AEC standard for the oxide is 200 times more restrictive. A sample representing 30 m^3 of air is collected and an aliquot of this is counted in a liquid scintillation spectrometer. The average concentrations of tritium oxide measured during 1972 were all less than approximately 0.1 percent of the AEC standard. These results are summarized in table 18.

Table 18. Atmospheric monitoring for tritium oxide, Mound Laboratory, January-December 1972

Location	Number of samples	Range (pCi/m^3)	Average concentration [a] (pCi/m^3)	Percent of AEC standard [b]
Onsite:				
211	26	<3– 290	77 ± 7	0.04
212	26	<3–2 200	200 ±10	.1
213	26	<3–1 250	110 ± 8	.05
214	26	<3– 690	82 ± 7	.04
215	26	<3– 430	51 ± 6	.03
Offsite:				
101	46	<3– 580	101 ± 6	.1
102	37	<3– 250	61 ± 5	.09
103	45	<3–1 640	81 ± 6	.1
104	42	<3– 270	30 ± 4	.04
105	45	<3– 110	12 ± 2	.02
106	45	<3– 59	7.5± 1.6	.01
107	43	<3– 25	3.6± 1.1	.005
108	44	<3– 16	3.2± 1.1	.005
109	45	<3– 21	4.1± 1.1	.006
110	43	<3– 79	4.9± 1.2	.007

[a] Minimum detection limit (MDL) for tritium oxide in air is 3 pCi/m^3.
[b] The applicable AEC radiation standard for tritium in air is 200 nCi/m^3 for onsite locations and 70 nCi/m^3 for offsite locations.

An onsite perimeter network of five continuous, high-volume air samplers became operational during July 1972. This network replaced three interim samplers in operation since 1970. Particulate and gas samples are collected by the onsite samplers at the same flow rate as the offsite samplers (i.e., 1 m^3/min and 3000 cm^3/min, respectively).

The samples are also analyzed in the same manner as the offsite samples with the exception that all onsite samples are analyzed for polonium-210. The results of the onsite polonium-210 analyses are summarized in table 16. The average concentrations of polonium-210, measured during 1972 at the onsite sampling stations, were all less than 0.01 percent of the AEC standard. The AEC standard used for comparison for these onsite samples as well as plutonium and tritium oxide samples is the guide for an uncontrolled area.

The average plutonium-238 concentrations measured onsite were all less than 0.6 percent of the AEC standard and are summarized in table 17. The results of the onsite tritium oxide analyses are summarized in table 18. The average concentrations measured were all less than 0.1 percent of the AEC standard.

Water monitoring

Water sampling locations along the bank of the Great Miami River were revised during the first half of 1972. The revised locations will provide samples which are more representative of river water after proper mixing of Mound's effluent has occurred. Guidelines proposed by the federal EPA were utilized in selecting the new sampling locations. These locations are shown in figure 6. Water samples are collected at these locations daily and are subjected to

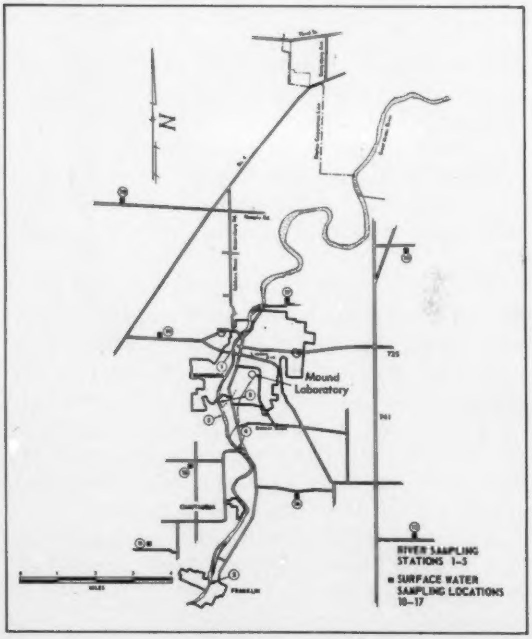

Figure 6. Offsite water monitoring stations, Mound Laboratory

specific analyses for polonium-210, plutonium-238 and tritium oxide. The concentrations of polonium-210 measured in the Great Miami River are summarized in table 19. The average concentrations were all less than 0.3 percent of the AEC standard.

Table 19. Polonium-210 concentrations in the Great Miami River, Mound Laboratory, January-December 1972

Location	Number of samples	Range (pCi/liter)	Average concentration [a] (pCi/liter)	Percent of AEC standard [b]
1	165	<0.13-1.5	0.44±0.37	0.2
2	165	<.13-1.6	.41± .36	.2
3	165	<.13-1.7	.59± .38	.3
4	165	<.13-1.1	.37± .34	.2
5	165	<.13-2.2	.40± .35	.2

[a] Minimum detection limit (MDL) for polonium-210 in water is 0.13 pCi/liter.
[b] The applicable AEC radiation protection standard for polonium-210 is 200 pCi/liter.

The concentrations of plutonium-238 measured in the Great Miami River are summarized in table 20. The average concentrations were less than 0.1 percent of the AEC standard.

The average concentrations of tritium oxide measured in the Great Miami River were all less than 0.5 percent of the AEC standard. These results are summarized in table 21.

Table 20. Plutonium-238 concentrations in the Great Miami River, Mound Laboratory, January-December 1972

Location	Number of samples	Range (pCi/liter)	Average concentration [a] (pCi/liter)	Percent of AEC standard [b]
1	165	0.1-16	1.0±0.1	0.05
2	165	.3- 8.0	.6± .09	.03
3	165	.2- 6.5	2.2± .2	.1
4	165	.1- 8.7	2.0± .2	.1
5	165	.1-27	2.3± .2	.1

[a] Minimum detection limit (MDL) for plutonium-238 in water is 0.008 pCi/liter.
[b] The applicable AEC radiation protection standard for plutonium-238 in water is 2 000 pCi/liter.

Table 21. Tritium concentrations in the Great Miami River, Mound Laboratory, January-December 1972

Location	Number of samples	Range (nCi/liter)	Average concentration [a] (nCi/liter)	Percent of AEC standard [b]
1	165	<0.3- 2.5	0.8±0.3	0.08
2	165	<.3-105	4.8± .5	.5
3	165	<.3- 15	2.2± .4	.2
4	165	<.3- 8.2	1.1± .4	.1
5	165	<.3- 1.9	.9± .4	.09

[a] Minimum detection limit (MDL) for tritium in water is 0.3 nCi/liter.
[b] The applicable AEC radiation protection standard for tritium in water is 1 000 nCi/liter.

Eight additional surface water locations such as ponds and streams are sampled quarterly. These locations are shown in figure 6. A sample of approximately 4 liters is collected at each location and analyzed for plutonium-238, polonium-210, and tritium oxide. The average concentrations of polonium-210 measured at the surface water locations during 1972 were less than 0.1 percent of the AEC standard. The average concentrations of plutonium-238 measured at these locations during 1972 were less than 0.03 percent of the AEC standard. The average concentrations of tritium oxide measured at these locations were less than 0.6 percent of the AEC standard. The results of the surface water monitoring program are summarized in tables 22, 23, and 24.

Drinking water from communities in the surrounding area is sampled quarterly and analyzed for tritium oxide. The concentrations of tritium oxide were found to be less than 1.3 percent of the AEC standard. The results of the community drinking water sampling program are summarized in table 25.

Table 22. Summary of surface water monitoring for polonium-210, Mound Laboratory, January-December 1972

Location	Number of samples	Range (pCi/liter)	Average concentration [a] (pCi/liter)	Percent of AEC standard [b]
10	3	0.05-.45	0.27±0.17	0.1
11	3	.15-.27	.20± .15	.1
12	3	<.03-.27	.16± .15	.08
13	3	<.03-.45	.18± .15	.09
14	3	<.03-.32	.16± .15	.08
15	3	<.03-.14	.09± .14	.05
16	3	.09-.31	.22± .16	.1
17	3	<.03-.32	.13± .15	.07

[a] Minimum detection limit (MDL) for polonium-210 in water is 0.03 pCi/liter.
[b] The applicable AEC radiation protection standard for polonium-210 in water is 200 pCi/liter.

Table 23. Summary of surface water monitoring for plutonium-238, Mound Laboratory, January-December 1972

Location	Number of samples	Range (pCi/liter)	Average concentration [a] (pCi/liter)	Percent of AEC standard [b]
10	2	0.07-0.11	0.09±0.01	0.005
11	2	.02- .05	.04± .003	.002
12	2	.07- .09	.08± .004	.004
13	2	.05- .15	.10± .01	.005
14	2	.07- .15	.11± .01	.005
15	2	.07- .10	.09± .01	.005
16	2	.07- .17	.10± .01	.005
17	2	.27- .78	.53± .04	.026

[a] Minimum detection limit (MDL) for plutonium-238 is 0.04 pCi/liter.
[b] The applicable AEC radiation protection standard for plutonium-238 in water is 2 000 pCi/liter.

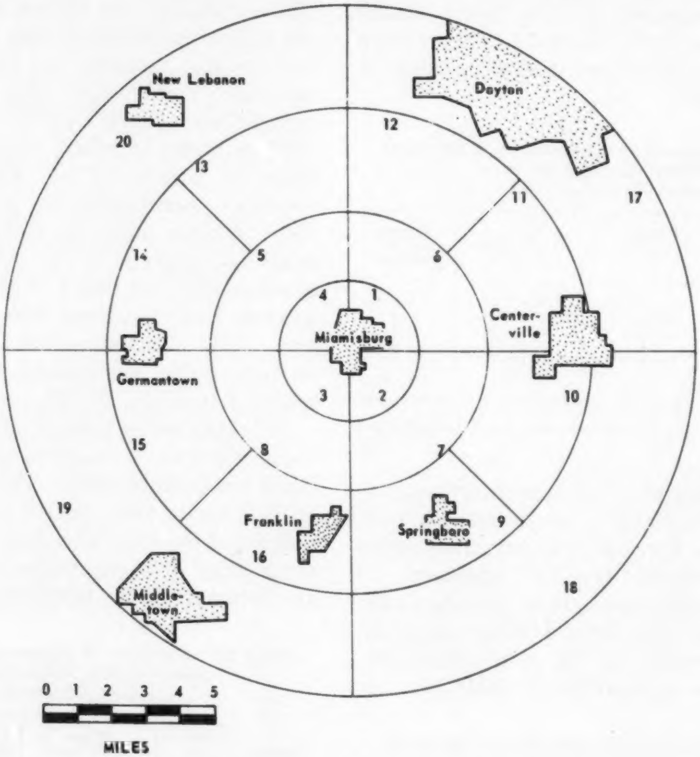

Figure 7. Soil sampling sectors, Mound Laboratory

Table 24. Summary of surface water monitoring for tritium, Mound Laboratory, January-December 1972

Location	Number of samples	Range (nCi/liter)	Average concentration [a] (nCi/liter)	Percent of AEC standard [b]
10	4	<0.3–1.4	0.7±0.2	0.07
11	4	<.3–1.0	.6± .2	.06
12	4	<.3–1.5	.5± .2	.05
13	4	<.3– .5	.3± .2	.03
14	4	3.1–9.3	6.0± .2	.60
15	4	1.8–4.4	3.5± .2	.35
16	4	.4–2.8	1.3± .2	.13
17	4	3.7–6.2	4.7± .2	.47

[a] Minimum detection limit (MDL) for tritium in water is 0.3 nCi/liter.
[b] The applicable AEC radiation protection standard for tritium oxide in water is 1 000 nCi/liter.

Food and vegetation

Various locally grown foodstuffs and vegetation samples are collected from the surrounding area. Where possible, sampling sites are chosen at maximum deposition locations predicted on the basis of the diffusion model previously mentioned. The samples collected include milk, fruits, vegetables, grass, field crops and aquatic life. The intent of this portion of the Environmental Monitoring Program is to determine if there is any uptake and concentration of radionuclides by plant or animal

Table 25. Summary of community drinking water tritium oxide levels, Mound Laboratory, January-December 1972

Location	Number of samples	Range (nCi/liter)	Average concentration [a] (nCi/liter)	Percent of AEC standard [b]
Bellbrook	4	<0.3– 0.8	0.4±0.2	0.04
Carlisle	1	----------	1.4± .2	.14
Centerville	2	.4– .5	.4± .2	.04
Dayton	4	<.3– .5	.3± .2	.03
Eaton	1	----------	<.3± .2	<.03
Franklin	3	.3– 1.6	1.0± .2	.10
Germantown	1	----------	1.1± .2	.11
Miamisburg	5	10 –17	12.5± .2	1.25
Middletown	1	----------	.3± .2	.03
Moraine	1	----------	.3± .2	.03
Springboro	3	<.3	<.3± .2	<.03
Tipp City	1	----------	<.3± .2	<.03
Waynesville	2	<.3– .5	.4± .2	.04
West Carrollton	1	----------	.4± .2	.04
West Milton	1	----------	<.3± .2	<.03

[a] Minimum detection limit (MDL) for tritium oxide is 0.3 nCi/liter.
[b] The applicable AEC radiation protection standard for tritium oxide in water is 1 000 nCi/liter.

Table 26. Summary of foodstuffs and vegetation analysis, Mound Laboratory January-December 1972

Type of sample	Number of samples	Plutonium-238 (fCi/g wet weight) [a]		Percent of AEC standard [b]	Tritium (pCi/g wet weight) [c]		Percent of AEC standard [d]
		Range	Average concentration [a]		Range	Average concentration [c]	
Milk	7	0.09–4.6	1.4±0.07	0.07	<0.1	<0.1	<0.01
Fruits and vegetables	6	1.7 –2.1	2.0± .2	.1	2.2– 2.8	2.3±0.1	.23
Grass	8	.5 –2.0	1.1± .1	.05	28 –103	49 ± .2	4.9
Field crops	2	.57– .64	.6± .1	.03	<.1– 16	8.2± .2	.8
Aquatic life	1	----------	6.0± .6	.3	<.1	<.1	<.01

[a] Minimum detection limit (MDL) for plutonium-238 in foodstuffs is 0.015 fCi/g.
[b] The applicable AEC radiation protection standard for plutonium-238 is 2 pCi/g.
[c] Minimum detection limit for tritium in foodstuffs is 0.1 pCi/g.
[d] The applicable AEC radiation protection standard for tritium oxide is 1 000 pCi/g.

life. As mentioned previously, commercial sales of polonium-210 from Mound Laboratory have ceased and, since air and water are monitored for polonium-210, foodstuff samples are not analyzed for polonium-210. The plutonium-238 content of the foodstuff and vegetation samples is determined by slowly evaporating the samples to dryness and then proceeding with the same techniques used for plutonium-238 analyses of air samples. Milk samples are analyzed for tritium oxide by distilling the water fraction from an aliquot of the entire sample. The distillate is then analyzed for tritium by liquid scintillation spectrometry in the same manner as the water samples previously discussed in this report. The remaining food samples are analyzed for tritium by oxidizing the samples in a controlled air stream and collecting the combustion products.

The tritium content of the combustion products is then determined by liquid scintillation spectrometry as discussed above. This technique allows analysis for total tritium in the samples rather than tritium oxide. The results of the food and vegetation analyses are summarized in table 26. The concentration is given in terms of the sample weight before evaporation to dryness. The vegetables analyzed included cucumbers, turnips, onions, and tomatoes. The sample of aquatic life analyzed included only the edible fleshy portions from six small bluegills. The concentration of tritium measured in grass samples appears to be measurably above background concentrations, but still well within the AEC standards. These results are the first utilizing the total tritium technique at Mound Laboratory. More data must be accumulated before any conclusion can be reached. No

other indication has been found that there is any significant uptake and concentration by plant or animal life of these radionuclides handled at Mound Laboratory.

Soil and silt

The soil sampling program has included two aspects of soil monitoring. One aspect, which was reported in MLM–1922 *Environmental Monitoring Report, July–December 1971 and 1971 Summary*, is the evaluation of the resuspendable amounts of plutonium-238 in soil. For this evaluation surface scrapings, approximately 3 mm deep, of undisturbed soil are collected and analyzed. Review of data reported in 1971 revealed that evaluation of resuspendable plutonium in soil is best accomplished by the network of continuous high-volume air samplers. Therefore, surface soil sampling was suspended during 1972. If air sampling results indicate a potential problem in this area, surface soil sampling will be resumed. The second aspect of soil monitoring is the documentation for historical purposes of the total accumulation and distribution of plutonium deposited offsite, and for verification of Mound Laboratory's atmospheric diffusion model. Present plans are to repeat and refine the total inventory at 5-year intervals once the initial inventory is completed.

Soil core samples 9 cm in diameter, approximately 30 cm deep, are taken for the inventory determination. Core samples were collected at two locations in each quadrant around the laboratory during 1972. Five cores were collected from a square area 9 meters on a site at each location and composited to form one core sample. Additional core samples for background control data were taken from locations greater than 80 km from the laboratory.

Soil samples are digested with an acid mixture to extract the plutonium. The solution is then passed over an ion exchange column specific for plutonium and analyzed in the same manner as the particulate air samples previously discussed in this report. This leach method has been compared with a fusion method for soil analysis (*4*). Good agreement was obtained between the two methods of analysis. The leach method was chosen for the soil analysis because larger samples, which minimize sampling and aliquoting errors and increase sensitivity, can be handled with this method. The results of the core sampling program are summarized in table 27. As mentioned previously in this report, no standards have been established for radioactive species in soil. Additional sample analyses are necessary before a total inventory can be calculated, and these are continuing as part of Mound Laboratory's comprehensive environmental control program.

Table 27. Plutonium-238 results in soil core samples, Mound Laboratory, January-December 1972

Location		Plutonium-238 [a] (nCi/m²)
Direction	Distance (km)	
North:	1.4	18 ±2
	4.2	1.7 ± .2
East:	.8	94 ±9
	1.9	8.9 ± .9
South:	1.0	3.0 ± .3
	2.3	3.7 ± .4
West:	.8	9.0 ± .9
	2.1	2.3 ± .2
Background		.05 ± .005

[a] Minimum detection limit for plutonium-238 in soil is 0.004 nCi/m².

Silt samples are collected quarterly from four locations on the Great Miami River. These samples are taken at four of the same locations that water samples are taken from and are identified by the same numbers shown in figure 7. Additional silt samples are collected annually from the same surface water locations which are sampled monthly. The silt samples are analyzed in the same manner as the soil samples. The results of Great Miami River silt sampling for 1972 are summarized in table 28.

Table 28. Summary of Great Miami River silt samples for plutonium-238, Mound Laboratory, January-December 1972

Location	Number of samples	Range (fCi/g)	Average concentration [a] (fCi/g)
1	3	50–190	121 ± 3
2	3	60–3500	1330 ± 10
3	4	40–130	94.4 ± 3
4	4	200–1700	531 ± 6
5	2	290–1350	821 ± 8

[a] Minimum detection limit for plutonium-238 in silt samples is0.5 fCi/g. The concentration is in terms of standard dry weight.

The results of the silt sampling from the area ponds are summarized in table 29. There ap-

Table 29. Concentrations of plutonium-238 in pond silt, Mound Laboratory, January-December 1972

Location	Plutonium-238 [a] (fCi/g)
10	10.9±0.9
11	6.1± .7
12	13.0±1.0
13	3.1± .5
14	8.5± .8
15	7.6± .8
16	11.8±1.0
17	58.2±2.1

[a] Minimum detection limit for plutonium-238 in silt samples is 0.5 fCi/g The concentration is in terms of standard dry weight.

pears to be a very slight accumulation of plutonium-238 in river silt from the very small amounts of plutonium-238 which are discharged to the river. However, as mentioned previously, there does not appear to be any reentrainment of plutonium-238 by plant or animal life in the river nor by the river itself. No significant accumulation is indicated, however, by the pond silt data. As previously mentioned in this report, there are no standards for radioactive species in soil or silt.

Summary

The average concentrations of polonium-210, plutonium-238, and tritium detected in the environment surrounding Mound Laboratory, Miamisburg, Ohio, are presented for calendar year 1972. The average concentrations of these radioisotopes were well within the stringent standards adopted by the Atomic Energy Commission.

Atmospheric monitoring for radioactive species was upgraded by the completion of an offsite network of 10 continuous, high-volume air sampling stations during February 1972. Prior to that time, a routine offsite grab sampling program had been in effect since laboratory operations began in 1949. An additional 11 air sampling stations are scheduled for completion by the first quarter of 1973. The average concentrations of polonium-210, plutonium-238, and tritium measured in air during this period were less than 0.02 percent, 0.3 percent, and 0.1 percent of their respective AEC standards. A comparison to results obtained from grab sampling during 1971 is not warranted since the offsite network in 1972 utilized continuous sampling rather than grab sampling.

Water monitoring for radioactive species found the average concentrations of polonium-210, plutonium-238, and tritium measured at the water sampling locations during this period to be less than 0.3 percent, 0.1 percent, and 0.5 percent of their respective AEC standards. These results represent a significant reduction in concentrations of polonium-210 and tritium over those measured during 1971.

Additionally, data concerning radioactive species in surface water, community drinking water, foodstuffs, soil and silt are presented. No significant uptake of radioactive species from air or water by plant or animal life has been observed. No reentrainment of radioactive species from soil or silt is indicated at this time. Soil core sample analyses will continue to establish a plutonium-238 soil inventory as part of the total program to assess the impact of the laboratory's operations on the environment.

These data reflect the effectiveness of Mound's Environmental Control Program and indicate that the operation of the laboratory has negligible effect on the environment.

Previous coverage in Radiation Data and Reports:

Period	Issue
January–December 1971	March 1974

REFERENCES

(1) STATE OF OHIO. Statistical abstract of Ohio—1969. State of Ohio Economic Research Division (March 1969) p. 6.

(2) U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE; CONSUMER PROTECTION AND ENVIRONMENTAL HEALTH SERVICE and NATIONAL AIR POLLUTION CONTROL ADMINISTRATION. Report for consultation on the metropolitan Dayton intrastate air quality control region (September 1969) p. 11.

(3) EIMUTIS, E. C., R. P. QUILL and W. H. WESTENDORF. Development of an atmospheric diffusion model for optimum location of sampling sites in the Mound Laboratory environment, Final Report Phase I. Monsanto Research Corporation, Dayton Laboratory, Dayton, Ohio (June 25, 1971) p. 31.

(4) BISHOP, C. T., W. E. SHEEHAN, R. K. GILLETTE and B. ROBINSON. Comparison of a leaching method and a fusion method for the determination of plutonium-238 in soil. Presented at Distribution and Measurement of Plutonium in the Environment, Los Alamos Scientific Laboratory, Los Alamos, New Mex. (August 4–5, 1971).

Nuclear Power Reactors in the United States
September 30, 1974

Each quarter year, the Atomic Energy Commission releases information on the status of all present and proposed civilian nuclear power generating units in the United States. This information is reproduced for interested readers of *Radiation Data and Reports.*

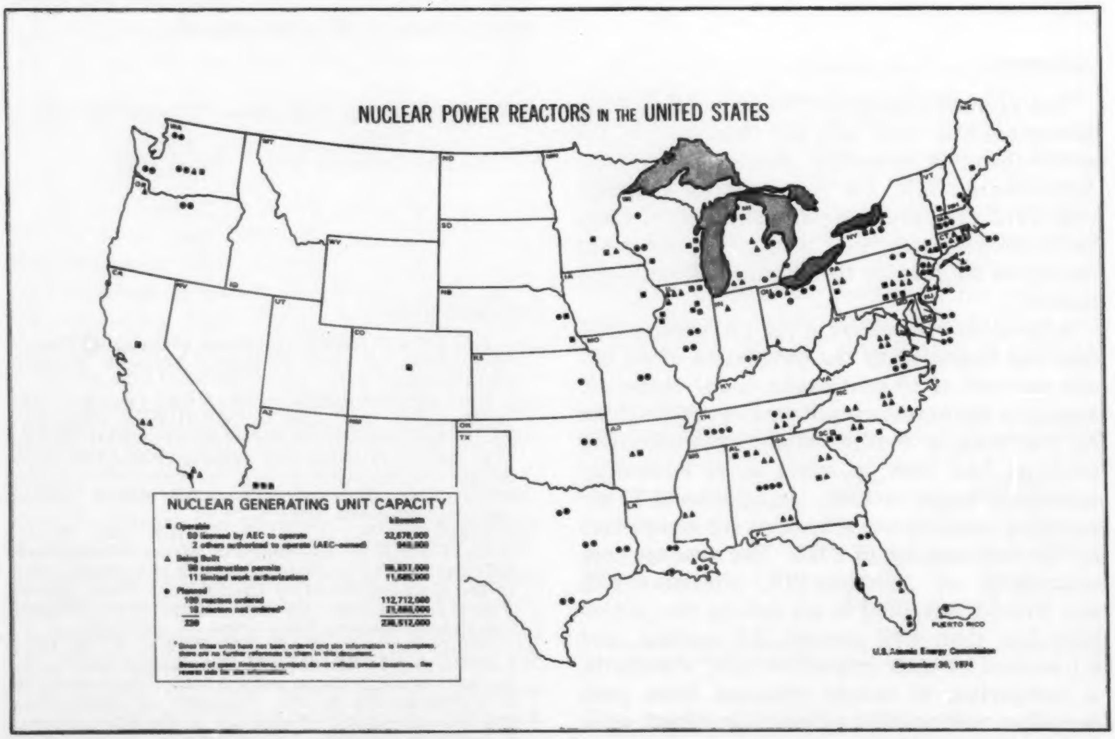

Figure 1. Nuclear power reactors in the United States, September 30, 1974

SITE	PLANT NAME	CAPACITY (Net Kilowatts)	UTILITY	COMMERCIAL OPERATION
ALABAMA				
Decatur	Browns Ferry Nuclear Power Plant: Unit 1	1,065,000	Tennessee Valley Authority	1974
Decatur	Browns Ferry Nuclear Power Plant: Unit 2	1,065,000	Tennessee Valley Authority	1974
Decatur	Browns Ferry Nuclear Power Plant: Unit 3	1,065,000	Tennessee Valley Authority	1975
Dothan	Joseph M. Farley Nuclear Plant: Unit 1	829,000	Alabama Power Co.	1976
Dothan	Joseph M. Farley Nuclear Plant: Unit 2	829,000	Alabama Power Co.	1977
Clanton	Alan R. Barton Nuclear Plant: Unit 1	1,159,000	Alabama Power Co.	1984
Clanton	Alan R. Barton Nuclear Plant: Unit 2	1,159,000	Alabama Power Co.	1985
Clanton	Alan R. Barton Nuclear Plant: Unit 3	1,159,000	Alabama Power Co.	1986
Clanton	Alan R. Barton Nuclear Plant: Unit 4	1,150,000	Alabama Power Co.	1987
Scottsboro	Bellefonte Nuclear Plant: Unit 1	1,213,000	Tennessee Valley Authority	1979
Scottsboro	Bellefonte Nuclear Plant: Unit 2	1,213,000	Tennessee Valley Authority	1980
ARIZONA				
Wintersburg	Palo Verde Nuclear Generation Station: Unit 1	1,270,000	Arizona Public Service	1981
Wintersburg	Palo Verde Nuclear Generating Station: Unit 2	1,270,000	Arizona Public Service	1982
Wintersburg	Palo Verde Nuclear Generating Station: Unit 3	1,270,000	Arizona Public Service	1984
ARKANSAS				
Russellville	Arkansas Nuclear One: Unit 1	850,000	Arkansas Power & Light Co.	1974
Russellville	Arkansas Nuclear One: Unit 2	912,000	Arkansas Power & Light Co.	1976
CALIFORNIA				
Eureka	Humboldt Bay Power Plant: Unit 3	65,000	Pacific Gas and Electric Co.	1963
San Clemente	San Onofre Nuclear Generating Station: Unit 1	430,000	So. Calif. Ed. & San Diego Gas & El. Co.	1968
San Clemente	San Onofre Nuclear Generating Station: Unit 2	1,140,000	So. Calif. Ed. & San Diego Gas & El. Co.	1979
San Clemente	San Onofre Nuclear Generating Station: Unit 3	1,140,000	So. Calif. Ed. & San Diego Gas & El. Co.	1980
Diablo Canyon	Diablo Canyon Nuclear Power Plant: Unit 1	1,084,000	Pacific Gas and Electric Co.	1975
Diablo Canyon	Diablo Canyon Nuclear Power Plant: Unit 2	1,106,000	Pacific Gas and Electric Co.	1976
Clay Station	Rancho Seco Nuclear Generating Station	913,000	Sacramento Municipal Utility District	1975
*	–	1,128,000	Pacific Gas & Electric Co.	1981
*	–	1,128,000	Pacific Gas & Electric Co.	1982
COLORADO				
Platteville	Ft. St. Vrain Nuclear Generating Station	330,000	Public Service Co. of Colorado	1974
CONNECTICUT				
Haddam Neck	Haddam Neck Plant	575,000	Conn. Yankee Atomic Power Co.	1968
Waterford	Millstone Nuclear Power Station: Unit 1	652,100	Northeast Nuclear Energy Co.	1971
Waterford	Millstone Nuclear Power Station: Unit 2	828,000	Northeast Nuclear Energy Co.	1974
Waterford	Millstone Nuclear Power Station: Unit 3	1,156,000	Northeast Nuclear Energy Co.	1979
DELAWARE				
Summit	Summit Power Station: Unit 1	770,000	Delmarva Power & Light Co.	1981
Summit	Summit Power Station: Unit 2	770,000	Delmarva Power & Light Co.	1984
FLORIDA				
Florida City	Turkey Point Station: Unit 3	693,000	Florida Power & Light Co.	1972
Florida City	Turkey Point Station: Unit 4	693,000	Florida Power & Light Co.	1973
Red Level	Crystal River Plant: Unit 3	825,000	Florida Power Corp.	1974
Ft. Pierce	St. Lucie Plant: Unit 1	810,000	Florida Power & Light Co.	1975
Ft. Pierce	St. Lucie Plant: Unit 2	810,000	Florida Power & Light Co.	1979
*	–	1,300,000	Florida Power Corp.	–
*	–	1,300,000	Florida Power Corp.	–
GEORGIA				
Baxley	Edwin I. Hatch Nuclear Plant: Unit 1	786,000	Georgia Power Co.	1974
Baxley	Edwin I. Hatch Nuclear Plant: Unit 2	795,000	Georgia Power Co.	1978
Waynesboro	Alvin W. Vogtle, Jr. Plant: Unit 1	1,113,000	Georgia Power Co.	–
Waynesboro	Alvin W. Vogtle, Jr. Plant: Unit 2	1,113,000	Georgia Power Co.	–
ILLINOIS				
Morris	Dresden Nuclear Power Station: Unit 1	200,000	Commonwealth Edison Co.	1960
Morris	Dresden Nuclear Power Station: Unit 2	809,000	Commonwealth Edison Co.	1970
Morris	Dresden Nuclear Power Station: Unit 3	809,000	Commonwealth Edison Co.	1971
Zion	Zion Nuclear Plant: Unit 1	1,050,000	Commonwealth Edison Co.	1973
Zion	Zion Nuclear Plant: Unit 2	1,050,000	Commonwealth Edison Co.	1974
Cordova	Quad-Cities Station: Unit 1	800,000	Comm. Ed. Co.-Ia.-Ill. Gas & Elec. Co.	1972
Cordova	Quad-Cities Station: Unit 2	800,000	Comm. Ed. Co.-Ia.-Ill. Gas & Elec. Co.	1972
Seneca	LaSalle County Nuclear Station: Unit 1	1,078,000	Comm. Ed. Co.-Ia.	1978
Seneca	LaSalle County Nuclear Station: Unit 2	1,078,000	Comm. Ed. Co.-Ia.	1979
Bryon	Byron Station: Unit 1	1,120,000	Comm. Edison Co.	1980
Bryon	Byron Station: Unit 2	1,120,000	Comm. Edison Co.	1981
Braidwood	Braidwood: Unit 1	1,120,000	Comm. Edison Co.	1980
Braidwood	Braidwood: Unit 2	1,120,000	Comm. Edison Co.	1981
Clinton	Clinton Nuclear Power Plant : Unit 1	955,000	Illinois Power Co.	1980
Clinton	Clinton Nuclear Power Plant : Unit 2	955,000	Illinois Power Co.	1982
INDIANA				
Westchester	Bailly Generating Station	660,000	Northern Indiana Public Service Co.	1979
Madison	Marble Hill Nuclear Power Station: Unit 1	1,150,000	Public Service Indiana	1983
Madison	Marble Hill Nuclear Power Station: Unit 2	1,150,000	Public Service Indiana	1984
IOWA				
Palo	Duane Arnold Energy Center: Unit 1	500,000	Iowa Electric Light and Power Co.	1974
*		1,000,000	Iowa Electric Light and Power Co.	1983
KANSAS				
Burlington	Wolf Creek Generation Station: Unit 1	1,150,000	Kansas Gas & Electric–Kansas City P & L	1982
LOUISIANA				
Taft	Waterford Generating Station: Unit 3	1,113,000	Louisiana Power & Light Co.	1980
St. Francisville	River Bend Station: Unit 1	934,000	Gulf States Utilities Co.	1980
St. Francisville	River Bend Station: Unit 2	934,000	Gulf States Utilities Co.	1981
Alliance	St. Rosalie Generating Station: Unit 1	1,100,000	Louisiana Power & Light Co.	1982
Alliance	St. Rosalie Generating Station: Unit 2	1,100,000	Louisiana Power & Light Co.	1984
MAINE				
Wiscasset	Maine Yankee Atomic Power Plant	790,000	Maine Yankee Atomic Power Co.	1972

Figure 1. Nuclear power reactors in the United States, September 30, 1974—continued

SITE	PLANT NAME	CAPACITY (Net Kilowatts)	UTILITY	COMMERCIAL OPERATION
MARYLAND				
Lusby	Calvert Cliffs Nuclear Power Plant: Unit 1	845,000	Baltimore Gas and Electric Co.	1974
Lusby	Calvert Cliffs Nuclear Power Plant: Unit 2	845,000	Baltimore Gas and Electric Co.	1975
Douglas Point	Douglas Point Project Nuclear Gen. Station: Unit 1	1,178,000	Potomac Electric Power Co.	1982
Douglas Point	Douglas Point Project Nuclear Gen. Station: Unit 2	1,178,000	Potomac Electric Power Co.	1984
MASSACHUSETTS				
Rowe	Yankee Nuclear Power Station	175,000	Yankee Atomic Electric Co.	1961
Plymouth	Pilgrim Station: Unit 1	664,000	Boston Edison Co.	1972
Plymouth	Pilgrim Station: Unit 2	1,180,000	Boston Edison Co.	1980
Montague	–	1,150,000	Northeast Utilities	1981
Montague	–	1,150,000	Northeast Utilities	1983
MICHIGAN				
Big Rock Point	Big Rock Point Nuclear Plant	75,000	Consumers Power Co	1965
South Haven	Palisades Nuclear Power Station	700,000	Consumers Power Co.	1971
Lagoona Beach	Enrico Fermi Atomic Power Plant: Unit 2	1,093,000	Detroit Edison Co.	1976
Lagoona Beach	Enrico Fermi Atomic Power Plant: Unit 3	1,171,000	Detroit Edison Co.	1981
Bridgman	Donald C. Cook Plant: Unit 1	1,060,000	Indiana & Michigan Electric Co.	1974
Bridgman	Donald C. Cook Plant: Unit 2	1,060,000	Indiana & Michigan Electric Co.	1976
Midland	Midland Nuclear Power Plant: Unit 1	492,000	Consumers Power Co.	1980
Midland	Midland Nuclear Power Plant: Unit 2	818,000	Consumers Power Co.	1979
St. Clair County	Greenwood: Unit 2	1,200,000	Detroit Edison Co.	1982
St. Clair County	Greenwood: Unit 3	1,200,000	Detroit Edison Co.	1983
MINNESOTA				
Monticello	Monticello Nuclear Generating Plant	545,000	Northern States Power Co.	1971
Red Wing	Prairie Island Nuclear Generating Plant: Unit 1	530,000	Northern States Power Co.	1973
Red Wing	Prairie Island Nuclear Generating Plant: Unit 2	530,000	Northern States Power Co.	1974
MISSOURI				
Fulton	Callaway Plant: Unit 1	1,150,000	Union Electric Co. r Co.	1981
Fulton	Callaway Plant: Unit 2	1,150,000	Union Electric Co. r Co.	1983
MISSISSIPPI				
Port Gibson	Grand Gulf Nuclear Station: Unit 1	1,250,000	Mississippi Power & Light Co.	1979
Port Gibson	Grand Gulf Nuclear Station: Unit 2	1,250,000	Mississippi Power & Light Co.	1981
NEBRASKA				
Fort Calhoun	Ft. Calhoun Station: Unit 1	457,400	Omaha Public Power District	1973
Fort Calhoun	Ft. Calhoun Station: Unit 2	1,150,000	Omaha Public Power District	1983
Brownville	Cooper Nuclear Station	778,000	Nebraska Public Power District and Iowa Power and Light Co.	1974
NEW HAMPSHIRE				
Seabrook	Seabrook Nuclear Station: Unit 1	1,200,000	Public Service of N.H.	1979
Seabrook	Seabrook Nuclear Station: Unit 2	1,200,000	Public Service of N.H.	1981
NEW JERSEY				
Toms River	Oyster Creek Nuclear Power Plant: Unit 1	640,000	Jersey Central Power & Light Co.	1969
Forked River	Forked River Generating Station: Unit 1	1,070,000	Jersey Central Power & Light Co.	1980
Salem	Salem Nuclear Generating Station: Unit 1	1,090,000	Public Service Electric and Gas, N.J.	1976
Salem	Salem Nuclear Generating Station: Unit 2	1,115,000	Public Service Electric and Gas, N.J.	1979
Salem	Hope Creek Generating Station: Unit 1	1,067,000	Public Service Electric and Gas, N.J.	1981
Salem	Hope Creek Generating Station: Unit 2	1,067,000	Public Service Electric and Gas, N.J.	1983
Little Egg Inlet	Atlantic Generating Station: Unit 1	1,150,000	Public Service Electric and Gas, N.J.	1985
Little Egg Inlet	Atlantic Generating Station: Unit 2	1,150,000	Public Service Electric and Gas, N.J.	1987
•	–	1,150,000	Public Service Electric and Gas, N.J.	1990
•	–	1,150,000	Public Service Electric and Gas, N.J.	1992
NEW YORK				
Indian Point	Indian Point Station: Unit 1	265,000	Consolidated Edison Co.	1962
Indian Point	Indian Point Station: Unit 2	873,000	Consolidated Edison Co.	1973
Indian Point	Indian Point Station: Unit 3	965,000	Consolidated Edison Co.	1974
Scriba	Nine Mile Point Nuclear Station: Unit 1	625,000	Niagara Mohawk Power Co.	1969
Scriba	Nine Mile Point Nuclear Station: Unit 2	1,080,000	Niagara Mohawk Power Co.	1978
Ontario	R.E.Ginna Nuclear Power Plant: Unit 1	490,000	Rochester Gas & Electric Co.	1970
Brookhaven	Shoreham Nuclear Power Station	819,000	Long Island Lighting Co.	1977
Scriba	James A. Fitzpatrick Nuclear Power Plant	821,000	Power Authority of State of N.Y.	1973
•	Green County Nuclear Power Plant	1,160,000	Power Authority of State of N.Y.	1982
Jamesport	Jamesport 1	1,150,000	Long Island Lighting Co.	1981
Jamesport	Jamesport 2	1,150,000	Long Island Lighting Co.	1983
Oswego	Sterling Nuclear: Unit 1	1,150,000	Rochester Gas & Electric Co.	1982
NORTH CAROLINA				
Southport	Brunswick Steam Electric Plant: Unit 1	821,000	Carolina Power and Light Co.	1975
Southport	Brunswick Steam Electric Plant: Unit 2	821,000	Carolina Power and Light Co.	1974
Cowans Ford Dam	Wm. B. McGuire Nuclear Station: Unit 1	1,180,000	Duke Power Co.	1977
Cowans Ford Dam	Wm. B. McGuire Nuclear Station: Unit 2	1,180,000	Duke Power Co.	1977
Bonsal	Shearon Harris Plant: Unit 1	900,000	Carolina Power & Light Co.	1981
Bonsal	Shearon Harris Plant: Unit 2	900,000	Carolina Power & Light Co.	1982
Bonsal	Shearon Harris Plant: Unit 3	900,000	Carolina Power & Light Co.	1983
Bonsal	Shearon Harris Plant: Unit 4	900,000	Carolina Power & Light Co.	1984
Davie County	Perkins Nuclear Station: Unit 1	1,280,000	Duke Power Co.	1981
Davie County	Perkins Nuclear Station: Unit 2	1,280,000	Duke Power Co.	1982
Davie County	Perkins Nuclear Station: Unit 3	1,280,000	Duke Power Co.	1984
•	–	1,150,000	Carolina Power & Light Co.	1980s
•	–	1,150,000	Carolina Power & Light Co.	1980s
•	–	1,150,000	Carolina Power & Light Co.	1980s
OHIO				
Oak Harbor	Davis-Besse Nuclear Power Station: Unit 1	906,000	Toledo Edison-Cleveland El. Illum. Co.	1976
Oak Harbor	Davis-Besse Nuclear Power Station: Unit 2	906,000	Toledo Edison-Cleveland El. Illum. Co.	1982
Oak Harbor	Davis-Besse Nuclear Power Station: Unit 3	906,000	Toledo Edison-Cleveland El. Illum. Co.	1984
Perry	Perry Nuclear Power Plant: Unit 1	1,205,000	Cleveland Electric Illuminating Co.	1979
Perry	Perry Nuclear Power Plant: Unit 2	1,205,000	Cleveland Electric Illuminating Co.	1980
Moscow	Wm. H. Zimmer Nuclear Power Station: Unit 1	810,000	Cincinnati Gas & Electric Co.	1979
Moscow	Wm. H. Zimmer Nuclear Power Station: Unit 2	1,170,000	Cincinnati Gas & Electric Co.	1979

Figure 1. Nuclear power reactors in the United States, September 30, 1974—continued

SITE	PLANT NAME	CAPACITY (Net Kilowatts)	UTILITY	COMMERCIAL OPERATION
OKLAHOMA				
Inola	Black Fox Nuclear Station: Unit 1	950,000	Public Service of Oklahoma	1982
Inola	Black Fox Nuclear Station: Unit 2	950,000	Public Service of Oklahoma	1984
OREGON				
Prescott	Trojan Nuclear Plant: Unit 1	1,130,000	Portland General Electric Co.	1975
*		1,260,000	Portland General Electric Co.	1981
*		1,260,000	Portland General Electric Co.	1983
PENNSYLVANIA				
Peach Bottom	Peach Bottom Atomic Power Station: Unit 1	40,000	Philadelphia Electric Co.	1967
Peach Bottom	Peach Bottom Atomic Power Station: Unit 2	1,065,000	Philadelphia Electric Co.	1974
Peach Bottom	Peach Bottom Atomic Power Station: Unit 3	1,065,000	Philadelphia Electric Co.	1974
Pottstown	Limerick Generating Station: Unit 1	1,065,000	Philadelphia Electric Co.	1981
Pottstown	Limerick Generating Station: Unit 2	1,065,000	Philadelphia Electric Co.	1982
Shippingport	Shippingport Atomic Power Station: Unit 1	90,000	Duquesne Light Co.	1957
Shippingport	Beaver Valley Power Station: Unit 1	852,000	Duquesne Light Co.-Ohio Edison Co.	1975
Shippingport	Beaver Valley Power Station: Unit 2	852,000	Duquesne Light Co.-Ohio Edison Co.	1981
Goldsboro	Three Mile Island Nuclear Station: Unit 1	819,000	Metropolitan Edison Co.	1974
Goldsboro	Three Mile Island Nuclear Station: Unit 2	905,000	Jersey Central Power & Light Co.	1978
Berwick	Susquehanna Steam Electric Station: Unit 1	1,050,000	Pennsylvania Power and Light	1979
Berwick	Susquehanna Steam Electric Station: Unit 2	1,050,000	Pennsylvania Power and Light	1981
Fuller	Fulton Generating Station: Unit 1	1,140,000	Philadelphia Electric Co.	1984
Fuller	Fulton Generating Station: Unit 2	1,140,000	Philadelphia Electric Co.	1986
SOUTH CAROLINA				
Hartsville	H. B. Robinson S.E. Plant: Unit 2	700,000	Carolina Power & Light Co.	1971
Seneca	Oconee Nuclear Station: Unit 1	886,000	Duke Power Co.	1973
Seneca	Oconee Nuclear Station: Unit 2	886,000	Duke Power Co.	1973
Seneca	Oconee Nuclear Station: Unit 3	886,000	Duke Power Co.	1974
Broad River	Virgil C. Summer Nuclear Station: Unit 1	900,000	South Carolina Electric & Gas Co.	1978
Lake Wylie	Catawba Nuclear Station: Unit 1	1,153,000	Duke Power Co.	1979
Lake Wylie	Catawba Nuclear Station: Unit 2	1,153,000	Duke Power Co.	1980
Cherokee County	Cherokee Nuclear Station: Unit 1	1,280,000	Duke Power Co.	1982
Cherokee County	Cherokee Nuclear Station: Unit 2	1,280,000	Duke Power Co.	1983
Cherokee County	Cherokee Nuclear Station: Unit 3	1,280,000	Duke Power Co.	1984
TENNESSEE				
Daisy	Sequoyah Nuclear Power Plant: Unit 1	1,140,000	Tennessee Valley Authority	1976
Daisy	Sequoyah Nuclear Power Plant: Unit 2	1,140,000	Tennessee Valley Authority	1977
Spring City	Watts Bar Nuclear Plant: Unit 1	1,169,000	Tennessee Valley Authority	1978
Spring City	Watts Bar Nuclear Plant: Unit 2	1,169,000	Tennessee Valley Authority	1979
Oak Ridge	Clinch River Breeder Reactor Plant	350,000	U.S. Government	1980
Hartsville	–	1,205,000	Tennessee Valley Authority	1980
Hartsville	–	1,205,000	Tennessee Valley Authority	1981
Hartsville	–	1,205,000	Tennessee Valley Authority	1981
Hartsville	–	1,205,000	Tennessee Valley Authority	1982
TEXAS				
Glen Rose	Commanche Peak Steam Electric Station: Unit 1	1,150,000	Texas Utilities Services Inc.	1980
Glen Rose	Commanche Peak Steam Electric Station: Unit 2	1,150,000	Texas Utilities Services Inc.	1982
Jasper	Blue Hills: Unit 1	918,000	Gulf States Utilities	1982
Jasper	Blue Hills: Unit 2	918,000	Gulf States Utilities	1982
Wallis	Allens Creek: Unit 1	1,150,000	Houston Lighting & Power Co.	1980
Wallis	Allens Creek: Unit 2	1,150,000	Houston Lighting & Power Co.	1982
Matagorda County	South Texas Project	1,250,000	Central Power & Lt.-Houston Lt. & Power	1980
Matagorda County	South Texas Project	1,250,000	Central Power & Lt.-Houston Lt. & Power	1982
VERMONT				
Vernon	Vermont Yankee Generating Station	513,900	Vermont Yankee Nuclear Power Corp.	1972
VIRGINIA				
Gravel Neck	Surry Power Station: Unit 1	788,000	Virginia Electric & Power Company	1972
Gravel Neck	Surry Power Station: Unit 2	788,000	Virginia Electric & Power Company	1973
Mineral	North Anna Power Station: Unit 1	898,000	Virginia Electric & Power Company	1975
Mineral	North Anna Power Station: Unit 2	898,000	Virginia Electric & Power Company	1976
Mineral	North Anna Power Station: Unit 3	907,000	Virginia Electric & Power Company	1977
Mineral	North Anna Power Station: Unit 4	907,000	Virginia Electric & Power Company	1978
Gravel Neck	Surry Power Station: Unit 3	859,000	Virginia Electric & Power Company	1980
Gravel Neck	Surry Power Station: Unit 4	859,000	Virginia Electric & Power Company	1981
WASHINGTON				
Richland	N-Reactor/WPPSS Steam	850,000	Atomic Energy Commission	1966
Richland	WPPSS No. 1	1,206,000	Washington Public Power Supply System	1980
Richland	WPPSS No. 2	1,103,000	Washington Public Power Supply System	1977
Satsop	WPPSS No. 3	1,242,000	Washington Public Power Supply System	1981
Richland	WPPSS No. 4	1,250,000	Washington Public Power Supply System	1982
Satsop	WPPSS No. 5	1,240,000	Washington Public Power Supply System	1983
Sedro Woolley	Skagit Nuclear Project: Unit 1	1,277,000	Puget Sound Power & Light	1982
Sedro Woolley	Skagit Nuclear Project: Unit 2	1,277,000	Puget Sound Power & Light	1983
WISCONSIN				
Genoa	Genoa Nuclear Generating Station	50,000	Dairyland Power Cooperative	1971
Two Creeks	Point Beach Nuclear Plant: Unit 1	497,000	Wisconsin Michigan Power Co.	1970
Two Creeks	Point Beach Nuclear Plant: Unit 2	497,000	Wisconsin Michigan Power Co.	1972
Carlton	Kewaunee Nuclear Power Plant: Unit 1	541,000	Wisconsin Michigan Power Co.	1974
Ft. Aktinson	Koshkonong Nuclear Plant: Unit 1	900,000	Wisconsin Electric Power Co.	1981
Ft. Atkinson	Koshkonong Nuclear Plant: Unit 2	900,000	Wisconsin Electric Power Co.	1982
Durand	Tyrone Energy Park: Unit 1	1,150,000	Northern States Power Co.	1985
PUERTO RICO				
Arecibo	Norco Nuclear Power Station	583,000	Puerto Rico Water Resources Authority	1981

* Site not selected.

*	–	1,300,000	Tennessee Valley Authority	1982
*	–	1,300,000	Tennessee Valley Authority	1983
*	–	1,300,000	Tennessee Valley Authority	1983
*	–	1,300,000	Tennessee Valley Authority	1984
*	–	1,200,000	New England Electric System	1982
*	–	1,200,000	New England Electric System	1982

Figure 1. Nuclear power reactors in the United States, September 30, 1974—continued

Reported Nuclear Detonations, October 1974

(Includes seismic signals presumably from foreign nuclear detonations)

Seismic signals from a Soviet underground nuclear test were recorded by the United States. The signals originated at approximately midnight e.s.t., November 2, 1974, at the southern Novaya Zemlya nuclear test area and were equivalent to those of an underground nuclear explosion in the yield range of 3 to 4 megatons.

No nuclear detonations were conducted by the United States for November 1974.

Not all of the nuclear detonations in the United States are announced immediately, therefore, the information in this section may not be complete. A complete list of announced U.S. nuclear detonations may be obtained upon request from the Division of Public Information, U.S. Atomic Energy Commission, Washington, D.C. 20545.

Erratum

An error occurred in the units for the tritium concentrations in table 3 on page 345 of the June 1974 issue of *Radiation Data and Reports.* The concentrations in this table are in units of *n*Ci/liter instead of pCi/liter.

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SYNOPSES

Symposes of reports, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their files.

A SUMMARY OF LOW-LEVEL RADIOACTIVE WASTES BURIED AT COMMERCIAL SITES BETWEEN 1962–1973, WITH PROJECTIONS TO THE YEAR 2000. *M. F. O'Connell and W. F. Holcomb.* Radiation Data and Reports, Vol. 15, December 1974, pp. 759–767.

The U.S. Environmental Protection Agency contracted with the six States, having commercial burial facilities for low-level radioactive wastes, to obtain inventories of the types and quantities of wastes buried at these six sites. A compilation and interpretation of the inventory data is presented in tables and figures. Projections are made to the year 2000 of the quantity of low-level radioactive wastes that will result from the nuclear fuel cycle and nonfuel cycle sources. In addition, assumptions are made relating these projections to the available capacity and operational life of the commercial sites. Based on estimates of waste generation rates, it is indicated, assuming present operational practices, that by the year 1998, the six existing sites will exhaust their current burial capacity.

Keywords: commercial burial facilities, Illinois, Kentucky, Nevada, New York, nuclear fuel cycle, South Carolina, radioactive wastes, waste generation rates, Washington

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